

Bothalia

'N TYDSKRIF VIR PLANTKUNDIGE NAVORSING
A JOURNAL OF BOTANICAL RESEARCH

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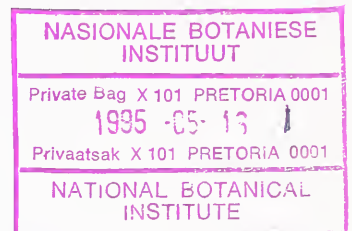
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Systematic studies in the genus *Mohria* (Pteridophyta: Anemiaceae). VI. Taxonomic review

J.P. ROUX*

Keywords: Anemiaceae, *Mohria*, taxonomy

ABSTRACT

A taxonomic review of the genus *Mohria* Sw. is presented, including diagnostic features, distribution and variation. A key to the taxa in the genus is provided and each species described.

UITTREKSEL

'n Taksonomiese oorsig van die genus *Mohria* Sw., waaronder kenmerkende eienskappe, verspreiding en variasie word aangebied. 'n Sleutel tot die taksons in die genus word verskaf en elke spesie word beskryf.

INTRODUCTION

The genus *Mohria* Sw. is largely an African one, occurring from the Western Cape in South Africa, along the eastern mountain ranges as far north as Kenya. Although the genus has a largely eastern distribution, two species, *M. lepigera* (Baker) Baker and *M. vestita* Baker, also occur on the Bihe Plateau in southern Angola. *Mohria*, furthermore, occurs on Madagascar and Réunion Island.

Mohria was first described by Plukenet (1700) as *Filicula geranii arvensis folio et facie aethiopica*. It was not until 1771 that Linnaeus in his *Mantissa plantarum altera* described *Polypodium caffrorum* from a König collection. König, a pupil of Linnaeus, was on his way to Tranquebar (India) but spent a short period (April 1–28, 1768) at the Cape of Good Hope, where he collected on Lion's Head, Table Mountain, Devil's Peak, the flats towards Constantia and along the sea shores (Gunn & Codd 1981).

The younger Linnaeus, however, in his *Supplementum plantarum* (1781), transferred *Polypodium caffrorum* L. to the genus *Adiantum* L. *P. caffrorum* has since been transferred to genera such as *Lonchitis* L. by Bernhardt (1801) and *Colina* by Greene (1893). Before describing the genus *Mohria* in 1806, Olaf Swartz initially placed what is today known as *Mohria caffrorum* in the genus *Osmunda* L. (Swartz 1801). At the time of publication of the genus *Mohria*, *M. thurifraga* was the only species known.

The genus *Mohria* honours Daniel Matthias Mohr, German botanist and later professor of philosophy at the University of Kiel (Stafleu & Cowan 1981).

A review of the genus has never been undertaken, with the result that all the collections, till recently, have either been placed in *M. caffrorum* or *M. lepigera*. The review

presented here is the result of studies on the morphology and anatomy of the rhizome and frond (Roux *et al.* 1992), vestiture morphology (Roux 1992a), sporangium and spore morphology (Roux 1992b) and karyology (Roux 1994).

TAXONOMIC REVIEW

***Mohria* Sw.**, Synopsis filicum: 6, 159 (1806). Type: *M. thurifraga* Sw., nom. superfl. [= *Polypodium caffrorum* L.; now *M. caffrorum* (L.) Desv.].

Terrestrial or lithophytic. *Rhizome* dictyostelic, prostrate or creeping, irregularly branched, scaled, often stoloniferous, stolons amphiphloic siphonosteles. *Fronde*s polystichous, erect or spreading, closely spaced or crowded, homomorphic to dimorphic; veneration circinate or non-circinate. *Stipe* terete, firm, variously set with naviculate trichomes, hairs and/or scales, fertile ones usually longer than sterile ones. *Lamina* pinnate to 3-pinnatifid, herbaceous to coriaceous. *Rachis* terete or adaxially shallowly sulcate, set with indumentum similar to that on stipe. *Pinnae* proximally short-stalked and widely spaced, distally sessile and overlapping, adaxially with clavate and naviculate trichomes, often also with hairs and/or small scales, abaxially variously set with clavate and naviculate trichomes, hairs and scales. *Pinnules* opposite to alternate, widely spaced or overlapping, venation free, ending near margin in lobe or teeth apices. *Stomata* anomo-, copolo-, desmo-, euperi-, eupolo-, para- and/or tripolocytic, amphistomic, hypostomic in *M. nudiuscula*. *Sporangia* exindusiate, usually borne on distal pinnae, borne singly near vein endings on short, massive stalks, globose; annulus terminal, 8–22-celled; stomium well defined. *Spores* tetrahedral, trilete, radially symmetrical, with ridges and grooves parallel to the equatorial plane, variously sculptured, 70–120 µm in diameter. *Chromosome number*: 2n = 76, 152.

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KEY TO SPECIES

- 1a Pinnae adaxially sparsely to densely hirsute:
 - 2a Lamina pinnate, oblanceolate to linear-attenuate; abaxially hirsute or with a few narrow to broad-ovate scales along rachis; proximal pinnae not reduced in size to base, closely spaced; rhizome stoloniferous 2. *M. marginalis*
 - 2b Lamina 2-pinnatifid to 2-pinnate, narrowly elliptic; abaxially sparsely to densely set with lanceolate to broad-ovate, pale to dark brown, entire scales; proximal pinnae widely spaced, decurrent, rhizome not stoloniferous 1. *M. lepigera*
- 1b Pinnae adaxially glabrous or sparsely set with short or long hairs largely along secondary rachises and veins:
 - 3a Vernation circinate; stipe and lamina scales spreading; exine ridges fossulate 4. *M. saxatilis*
 - 3b Vernation non-circinate; scales appressed or twisted but never spreading; exine ridges rounded:
 - 4a Fertile frond stipe significantly longer than sterile frond stipe; adaxial surface of pinnae with hairs only; hairs with sinuate transverse walls 3. *M. caffrorum*
 - 4b Fertile and sterile frond stipes of near equal length; adaxial surface of pinnae glabrous or with hairs and/or small scales, especially along secondary rachises; hair cells sinuous-walled or ossiform:
 - 5a Scales on abaxial surface of lamina narrowly linear to narrowly lanceolate, twisted; lamina usually >200 mm long, erect:
 - 6a Lamina herbaceous; pinnae adaxially sparsely hairy, especially along secondary rachises and veins; pinnule margins strongly dentate 6. *M. vestita*
 - 6b Lamina herbaceous to coriaceous; pinnae adaxially and abaxially glabrous or nearly so; pinnule margins shallowly dentate to crenate 7. *M. nudiuscula*
 - 5b Scales on abaxial surface of lamina lanceolate to ovate, appressed; lamina usually < 200 mm long, erect to spreading 5. *M. rigida*

1. *Mohria lepigera* (Baker) Baker in Annals of Botany 5: 498 (1891).

Notochlaeta lepigera Baker: 53 (1884). Type: Mount Dzomba, Zambesi-land (Malawi, Zomba Mountain), Kirk s.n. (K, lecto., here designated).

Mohria caffrorum (L.) Desv. var. *multisquamosa* Bonap.: 85 (1917). *M. lepigera* (Baker) Baker var. *madagascaria* Tardieu: 10 (1952). Type: Madagascar, Mont Intangabala, près Ihosy, 1 000 m, Perrier de la Bâthie 7849 (P, holo.).

Terrestrial or lithophytic. *Rhizome* prostrate, short, up to 4 mm in diameter, densely set with roots, stipe bases and scales; scales 0.8–5.0 × 0.2–0.9 mm, scarious, castaneous, adnate, linear to narrowly lanceolate, entire. *Fronds* few, erect, crowded; vernation non-circinate. *Stipe* terete, stramineous, up to 57.0 × 1.2 mm, set with hairs and scales; hairs up to 2.4 mm long, sinuous-walled; scales 0.9–3.8 × 0.3–1.4 mm, stramineous, adnate, cordate or cordate-imbricate, broadly ovate to lanceolate, entire. *Lamina* narrowly elliptic, up to 402 mm long, 2-pinnatifid to 2-pinnate, membranous to firmly herbaceous, with 12–39 pairs of pinnae. *Rachis* firm, proximally terete, distally adaxially shallowly sulcate, abaxially sparsely to densely set with stramineous scales similar in structure to those on abaxial lamina surface, reducing in size to frond apex, adaxially with naviculate trichomes and gland-tipped, straight-walled hairs similar to those on adaxial lamina surface. *Pinnae* 9.0–3.5 × 6–14 mm, opposite to alternate, proximally widely spaced and decurrent, crowded near apex, ovate to linear, abaxially sparsely to densely set with hairs and scales; hairs 0.6–2.2 mm long, sinuous-walled; scales 0.2–1.3 × 1.3–3.6 mm, lanceolate to broadly ovate, adaxially with naviculate trichomes and sparsely to densely hirsute, with hairs 0.4–2.6 mm long. *Pinnules* or segments opposite, 4–8 pairs per pinna, widely spaced to overlapping, ovate to circular, margins shallowly crenulate or lobed, terminating in 1 or 2 acute, falcate or obtuse teeth. *Spores* stramineous, broadly ridged, ridges closely spaced, colliculate. *Chromosome number* unknown. Figure 1A–H.

Diagnostic features

Mohria lepigera is characterized by its generally long and narrow frond outline, the short stipe in relation to the lamina length (\bar{x} = 1:10; n = 30), the often greatly reduced

and widely spaced proximal pinnae and the large, densely set stramineous to cream-coloured sinuous-walled scales which often cover the entire abaxial pinna surface. Clavate trichomes are 30.5–(42.52)–48.8 µm long and naviculate trichomes are 50.0–(113.44)–147.5 µm long.

Distribution and habitat

Mohria lepigera occurs in Tanzania, Burundi, Zaïre, Malawi, Mozambique, Zimbabwe and Madagascar (Figure 2). *M. lepigera* occurs from 1 200–2 400 m in habitats ranging from rock crevices or boulder bases and riverine fringes to moist open ground. Kornaś (1979) dealt with the ecology of the taxon in Zambia.

Variation

Mohria lepigera shows a fair amount of plasticity in the degree to which the lamina is divided, lamina size, texture and indumentum composition and density. Collections recorded from moist shaded conditions at higher elevations have relatively short, less dissected (2-pinnatifid) membranous fronds, whereas those from xeric environments have relatively long, 2-pinnate, firmly herbaceous fronds which are borne in an erect manner. The densely scaled abaxial surface which is typical of *M. lepigera* in some instances only bears filiform scales and hairs.

Vouchers: Brass 16484 (PRE, SRGH); Drummond & Hensley 2557 (PRE); Pichi Sempelli 7042 (BOL, SRGH); Polhill & Paulo 1634 (K); Taylor 3279 (NBG).

2. *Mohria marginalis* (Savigny) J.P. Roux in South African Journal of Botany 56: 401 (1990b).

Osmunda marginalis Savigny: 655 (1798). Type: Bourbon (Réunion), Commerson s.n. (P, lecto., designated by Roux 1990b).

O. thurifraga Comm. ex Savigny: 655 (1798), nom. nud.

O. thurifraga Comm. ex Bory: 348 (1804), nom. nud.

O. crenata Desv.: 307 (1811). Type: habitat in insula Bourboniae (Réunion), sine coll. (P, lecto., here designated).

Mohria hirsuta J.P. Roux: 435 (1984). Type: Qwa Qwa, Tsheseng, near cave on road to The Sentinel, Roux 907 (NBG, holo.; K, PRE, iso.).

Terrestrial or lithophytic. *Rhizome* prostrate, short, up to 3 mm in diameter, irregularly branched, stoloniferous, sparsely set with scales; scales $0.8\text{--}3.3 \times 0.2\text{--}0.5$ mm, stramineous, scarious, cordate, linear to narrowly lanceolate, entire. *Fronds* erect, crowded; vernation non-cir-

ciate. *Stipe* terete, firm, stramineous, up to 36×1 mm, sparsely set with naviculate trichomes, hairs and scales; hairs up to 2.7 mm long, sinuous-walled; scales $1.2\text{--}2.8 \times 0.3\text{--}0.9$ mm, cordate, narrowly lanceolate, narrowly ovate to linear-acuminate, entire or shallowly and uneven-

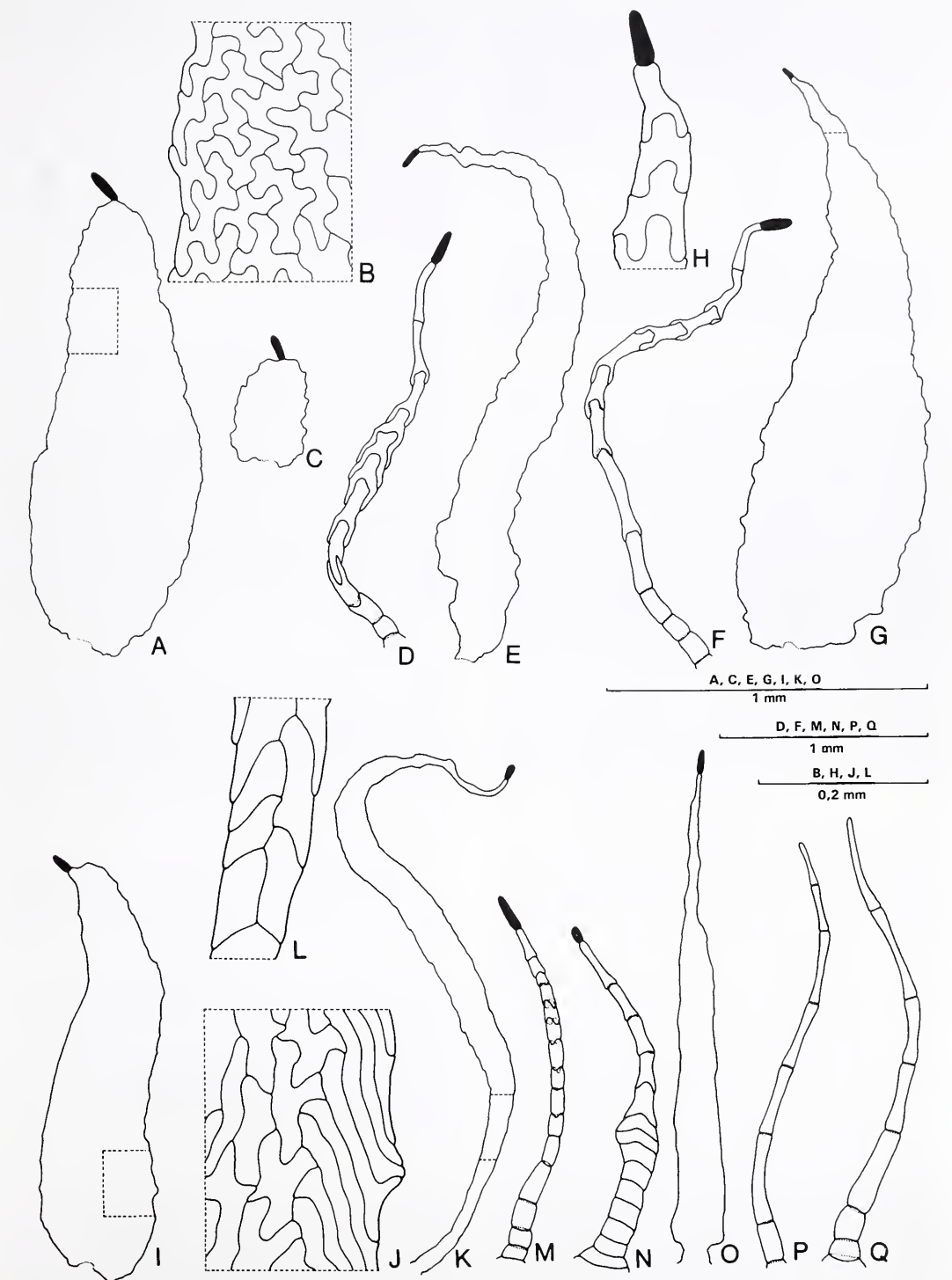


FIGURE 1.—Frond scales in *Mohria*. A–H, *M. lepiger*, Burrows 1686 (NBG). A–C, stipe; D, E, rachis; F, adaxial lamina surface; G, H, abaxial lamina surface. I–Q, *M. marginalis*, Roux 907 (NBG). I–M, stipe; N, O, rachis; P, adaxial lamina surface; Q, abaxial lamina surface. Scale bars: A, C, D–G, I, K, M–Q, 1 mm; B, H, J, L, 0.2 mm.

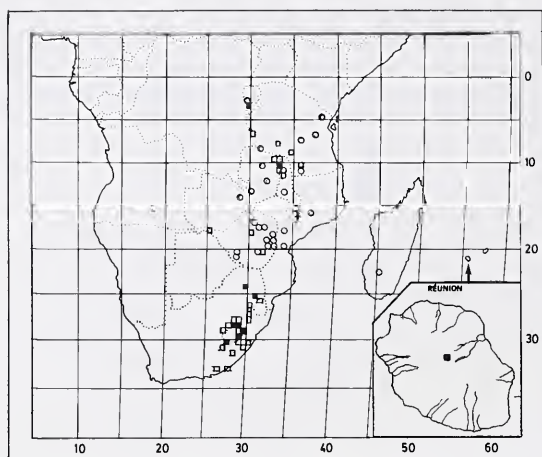


FIGURE 2.—Distribution of *Mohria lepigera*, ○; *M. marginalis*, ■; and *M. nudiuscula*, □.

ly crenulate. *Lamina* 33–131 mm long, oblanceolate to linear-attenuate, pinnate, firmly herbaceous, with 8–21 pairs of pinnae. *Rachis* terete, firm, distally somewhat flexuose, adaxially often shallowly sulcate, sparsely set with naviculate trichomes, hairs and filiform scales, which are absent at apex. *Pinnae* 4.4–14.7 × 5.5–8 mm, opposite to alternate, proximally widely spaced, crowded and overlapping distally, proximally short-stalked and circular to reniform, distally sessile and ovate to lanceolate, adaxially sparsely to densely hirsute, with straight-walled, often eglandular hairs, abaxially with sinuous-walled hairs up to 1 mm long and filiform scales; scales 1.6–2.6 × 0.1–0.2 mm, segments opposite, 2–5 pairs per pinna, usually overlapping slightly, rotund to ovate-obtuse, less deeply dissected towards lamina base and apex, shallowly crenulate to bluntly dentate. *Spores* stramineous, ridges widely spaced, ridges and grooves granulate, up to 82 µm in diameter. *Chromosome number*: $2n = 76$. Figure 11–Q.

Bory has always been considered as the author of *Osmunda thurifraga* (Schelpe 1970, 1977; Schelpe & Anthony 1986) but the name was published without a description. Bory (1804: 348) merely noted 'Dans les environs je trouvai une belle fougère, dont les feuilles froissées répandaient l'odeur de l'encens: je l'ai vue depuis dans l'herbier de M. de Jussieu, elle lui venait de Commerson, qui l'avait appelée *Osmunda thurifraga*.' It is therefore evident that he did not describe, nor had any intention to describe, the species, as in other parts of this work he either provided a short description or gave a reference to a previous work where he thought a taxon to be new. The name is therefore a *nomen nudum*.

Savigny (1798) also published Commerson's manuscript name *Osmunda thurifraga* as a *nomen nudum*, citing it as one of the elements used in his description of *O. marginalis*, the other being a Sonnerat collection from Réunion. The Commerson specimen in the herbarium of the Muséum National d'Histoire Naturelle, Paris (P) was designated as the lectotype of *O. marginalis* Savigny (Roux 1990b).

Desvaux (1811), in his description of *Mohria crenata*, gave the locality of the species as 'Habitat in insula Bourboniae' (Réunion), with no collector given. The specimen designated here as lectotype of *M. crenata* is a sheet which formerly formed part of Desvaux's herbarium and is currently housed in the herbarium of the Muséum National d'Histoire Naturelle, Paris (P).

Diagnostic features

Mohria marginalis is characterised by the relatively long and narrow, less dissected (2-pinnatifid) fronds, the usually eglandular, short-celled, straight-walled hairs on the frond, as well as the filiform scales and sinuous-walled hairs on the stipe, rachis and abaxial surface of the lamina. Clavate trichomes are 37.5–(48.75)–57.5 µm long and naviculate trichomes are 57.0–(104.3)–145.8 µm long.

Distribution and habitat

Mohria marginalis occurs from the southern Drakensberg in the northeastern Cape along the mountain ranges into central Africa, as far north as Burundi. It also occurs on Réunion (Figure 2). In the Drakensberg the taxon occurs in seasonally moist, often exposed situations at the rim of vegetation pockets commonly found in shallow depressions in the Clarens Sandstone formation, at boulder bases or among grass tussocks at higher elevations. Further north it has been recorded from rock crevices. The plants usually form large masses and may often grow alongside xerophytic ferns such as *Cheilanthes eckloniana* (Kunze) Mett., *Ophioglossum lancifolium* C. Presl and *M. rigida* J.P. Roux.

Variation

Slight variations occur in frond length, the number of segments per pinna and in the indumentum density on the stipe and rachis. Narrow hair-like scales often replace some of the hairs on the abaxial lamina surface.

Vouchers: *De Marie s.n.* (NBG); *Leighton 3224* (BOL); *Reekmans 8789* (PRE); *Roux 907, 1524* (NBG).

3. *Mohria cafferorum* (L.) Desv. in *Mémoires de la Société Linnéenne de Paris* 6, 2: 198 (1827). Type: habitat ad Cap. b. Spei., *König s.n.* [LINN 1251/67, lecto!., designated by Schelpe & Anthony (1986)].

Polypodium cafferorum L.: 307 (1771); *Adiantum cafferorum* (L.) L.f.: 447 (1781); *Lonchitis cafferorum* (L.) Bernh.: 124 (1801); *Colina cafferorum* (L.) Greene: 247 (1893); *Mohria thurifraga* Sw.: 159, 385 (1806) nom. superfl.

Osmunda thurifera Sw.: 105 (1801). Type: C.B.S. *Thunberg s.n.* [UPS, lecto!., designated by Schelpe & Anthony (1986)].

Cheilanthes fuscata Blume: 136 (1828). Type: Cape (L., holo!).

Mohria thurifraga Sw. var. *achillaeifolia* (as *achillaeifolia*) E.J. Lowe: 104, t. 62B (1862). Type: t. 62B (icono!).

Lithophytic or terrestrial. *Rhizome* prostrate, short and stout or slender and creeping, 2–6 mm in diameter, irregularly branched, stoloniferous, clothed with roots and scales; scales 1.6–2.8 × 0.3–0.8 mm, castaneous, adnate, lanceolate to ovate, acute to obtuse, entire. *Fronds* erect, approximate to crowded, fertile ones usually longer than sterile ones; vernation non-circinate. *Stipe* terete, firm, castaneous throughout or proximally castaneous and dis-

tally stramineous, 17–162 mm long, up to 1.7 mm in diameter, fertile one significantly longer than sterile one, densely set with naviculate trichomes, uniseriate hairs and scales, becoming glabrous later; scales $0.5\text{--}3.8 \times 0.1\text{--}1.5$ mm, of two types, variable, stramineous—larger scales linear, narrowly elliptic or lanceolate or broadly ovate, entire—smaller scales sessile or cordate, irregularly shaped or with fimbriate base. Sterile lamina 37–235 mm long, elliptic to oblanceolate, fertile lamina 75–270 mm long, narrowly elliptic to narrowly oblanceolate, 2-pinnatifid to 3-pinnate, with 8–26 pairs of pinnae. *Rachis* proximally terete or shallowly sulcate, narrowly winged and distally often flexuose, densely set with indumentum similar to that on abaxial pinna surface. *Pinnae* 9–30 \times 6.5–12.6 mm, proximally widely spaced, distally crowded and overlapping, ovate to oblong, proximally short-stalked, becoming sessile distally, adaxially with clavate and naviculate trichomes and few short or long sinuous-walled hairs, 0.4–1.4 mm long, largely on secondary rachis; secondary rachis narrowly winged, abaxially with clavate and naviculate trichomes, hairs and scales; hairs and scales sparsely to densely set, pale brown to whitish; scales $0.2\text{--}3.5 \times 0.1\text{--}1.3$ mm, cordate to cordate-imbricate, narrowly linear to lanceolate, ovate or circular at base, terminating abruptly in a long and narrow entire apex, proximally with short and long, straight or curved marginal outgrowths. *Pinnules* opposite to alternate, 4–9 pairs per pinna, widely spaced or overlapping, segments lobed, each terminating in 1 or 2 cuneate or falcate teeth. *Spores* stramineous, ridges and grooves glebulate, pustulate, finely verrucous or reticulate-verrucous. *Chromosome number*: $2n = 76$. Figure 3A–O.

Mohria thurifraga Sw. (1806) is a superfluous name for *Polypodium caffrorum* L. (1771). However, the concept of this species as construed by Swartz (1806) includes two different elements, namely a Cape taxon and a Réunion taxon. The latter was described as *Osmunda marginalis* Savigny based on collections by Commerson and Sonnerat from Réunion and is here upheld as a distinct species.

The description and illustration published by Lowe (1860) is that of *M. vestita* (No. 6). Here he mentions a dwarf form of this species which was known as *M. achilleifolia*. This he described as *M. thurifraga* var. *achilleifolia* in 1862. A Sim collection annotated by him as *M. thurifraga* var. *achilleifolia* from Zwaartberg near Pietermaritzburg, Natal, is housed in Pretoria (PRE) but this proved to be a variant of *M. vestita*. However, the illustration (t. 62B) provided by Lowe which is based on a Sim collection, judging by the size and laminar segmentation, appears to be a collection of *M. caffrorum*. The collection has obviously not been preserved and I therefore designate plate 62B as iconotype of *M. thurifraga* var. *achilleifolia*.

Diagnostic features

Mohria caffrorum is characterized by the branched, often widely creeping stoloniferous rhizome, the marked degree of dimorphism in the fertile frond stipe which is strikingly longer than the sterile frond stipe, indumentum structure and distribution, and spore ornamentation. Clavate trichomes are $55.0\text{--}(59.15)\text{--}67.5$ μm long and naviculate trichomes are $147.5\text{--}(179.8)\text{--}222.5$ μm long.

Distribution and habitat

Mohria caffrorum is found in the Northern, Western and Eastern Cape where it occurs in a wide range of ecological and climatic conditions (Figure 4). It grows at elevations ranging from almost sea level at Cape Point to $\pm 1\ 000$ m in the Cedarberg. Plants are generally found in small clonal clusters at boulder bases, in rock crevices or in light shade of shrubs, or in large stands in seasonally moist exposed situations. Fires, which are prevalent in most of the vegetation types in which the species occurs, appear to have no ill effect on the plants but rather stimulate them.

Variation

Scale density and scale outline or structure on the abaxial lamina surface show the most striking degree of variation. When scale variation throughout the distribution is viewed, a gradation in scale outline is detected from the west, becoming more complex to the east. Scale variation is especially apparent in the Gifberg/Vanrhynsdorp ecotype where the abaxial surface of the mature fronds of some plants is densely covered by large pale brown to whitish scales with sinuate-walled cells (Figure 3J–O).

M. caffrorum shows the highest degree of frond dimorphism. The difference between stipe length of the sterile and fertile fronds is the most significant. A relationship exists between frond and stipe length in the sterile frond ($r = 0.724$, $P < 0.001$) and the fertile frond ($r = 0.530$, $P < 0.001$). Fertile fronds proved to have a larger number of pinnae and pinnules than sterile fronds.

Vouchers: Barker 9790 (NBG); Dahlstrand 792 (GRA); Goldblatt 3667 (PRE); Perry 42 (NBG); Taylor 11833 (PRE, STE).

4. *Mohria saxatilis* J.P. Roux in Journal of South African Botany 56: 399 (1990a). Type: Cape Province, 3219 (Wuppertal); Wuppertal, west-facing cliff near experimental forest plot on road to Heuningvlei, (–AA), Roux 2012 (NBG, holo.!; K, PRE, iso.!).

Lithophytic. *Rhizome* prostrate, short, up to 5 mm in diameter, densely clothed with roots, closely spaced persistent stipe bases and scales; scales $1.0\text{--}3.7 \times 0.3\text{--}0.4$ mm, castaneous, adnate or cuneate, linear to narrowly lanceolate, entire. *Fronds* few, erect, caespitose, fertile ones slightly longer than sterile ones; vernation circinate. *Stipe* terete, firm, stramineous, 22.0–61.5 mm long, up to 1.2 mm in diameter, fertile one slightly longer than sterile one, densely set with scales; scales, $1.0\text{--}3.2 \times 0.5\text{--}1.1$ mm, stramineous, spreading, cuneate to cordate, narrowly lanceolate to ovate, shallowly and irregularly crenulate. *Lamina* elliptic to oblanceolate, 67–117 mm long, 2-pinnatifid, with 8–15 pairs of pinnae. *Rachis* proximally terete, distally narrowly winged and shallowly sulcate, adaxially with naviculate trichomes and sinuous-walled hairs, abaxially densely set with naviculate trichomes and scales similar in structure to those on stipe. *Pinnae* 11–24 \times 8–10 mm, opposite to alternate, oblong to ovate, obtuse, with 4–6 lobe pairs per pinna, each lobe terminating in a single tooth or paired acute teeth, abaxially densely set with naviculate trichomes and scales; scales $0.9\text{--}3.4 \times 0.3\text{--}0.9$ mm, stramineous, spreading, cuneate to cordate, narrowly lanceolate to ovate, entire or shallowly and un-

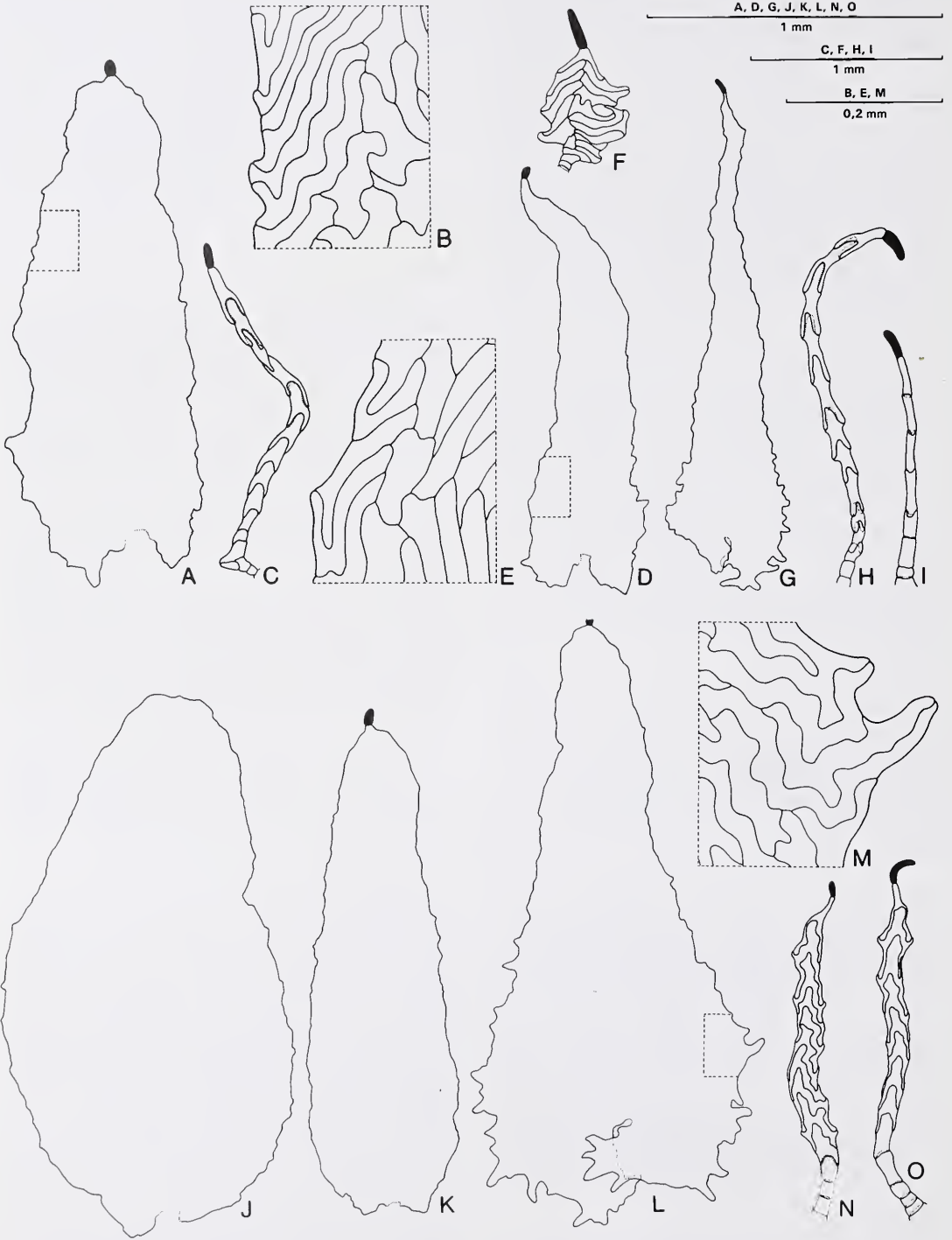


FIGURE 3.—Frond scales in *Mohria*. A–I, *M. caffrorum*, Roux 2014 (NBG). A–C, stipe; D–F, rachis; G, abaxial lamina surface; H, I, adaxial lamina surface. J–O, *M. caffrorum*, Roux 2015 (NBG). J, stipe; K, rachis; L, M, abaxial lamina surface; N, O, adaxial lamina surface. Scale bars: A, C, D, F, G–L, N, O, 1 mm; B, E, M, 0.2 mm.

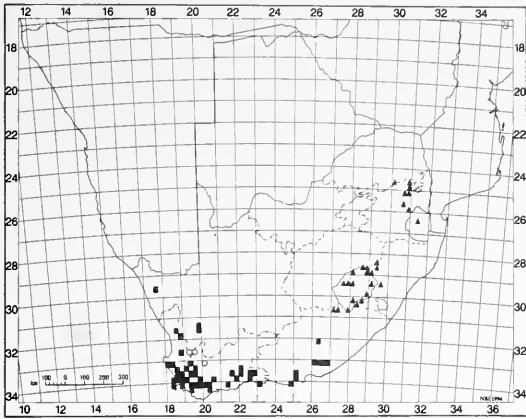


FIGURE 4.—Distribution of *Mohria caffrorum*, ■, *M. saxatilis*, ○; and *M. rigida*, ▲.

evenly crenulate, adaxially with naviculate trichomes and sparsely set with straight or sinuous-walled hairs along broadly winged secondary rachis, 0.9–3.3 mm long. *Spores* stramineous, ridges broad, fossulate, sparsely and irregularly verrucous, 75.4–92.8 µm in diameter. *Chromosome number*: $n = 76$. Figure 5A–K.

Diagnostic features

Mohria saxatilis is distinguished by the short prostrate rhizome, short stipe, the crowded fronds, the large spreading scales on the stipe and on the abaxial lamina surfaces, and the broadly winged costa. Diagnostic micromorphological characters are the larger clavate trichomes which are 61.1–(68.11)–76.4 µm long (Roux 1992a), and epidermal cells and the occurrence of copolycytic and tripolycytic stomata not found in any of the other taxa (Roux *et al.* 1992). Naviculate trichomes are 97.7–(139.05)–177.19 µm long.

Distribution and habitat

Mohria saxatilis is confined to the Table Mountain Sandstone formation and occurs from the Cedarberg to the Langeberg in the Worcester District. The species grows at elevations ranging from ± 1 000 to 1 500 m (Figure 4).

Vouchers: *Bean 259* (in part, A & B only) (BOL); *Compton 17993* (NBG); *Roux 2000* (NBG); *Roux 2003* (in part) (NBG); *Roux 2012* (K, NBG, PRE).

5. *Mohria rigida* J.P. Roux in South African Journal of Botany 56: 268 (1990a). Type: Qwa Qwa, at Clarens Sandstone cave on road to The Sentinel, Roux 1910 (NBG, holo.).

Lithophytic or terrestrial. *Rhizome* prostrate, short, up to 5 mm in diameter, densely clothed with roots, persistent stipe bases and scales; scales 3.6–5.6 × 0.3–0.6 mm, castaneous, adnate, narrowly lanceolate, entire. *Fronds* erect or spreading, caespitose, fertile ones slightly longer than sterile ones, vernation non-circinate. *Stipe* terete, firm, proximally castaneous, distally stramineous, 16–88 mm long, up to 1.3 mm in diameter, fertile one slightly longer

than sterile one, with sparse indumentum, becoming glabrous later; scales 0.5–3.4 × 0.3–0.8 mm, stramineous, variable, truncate, cordate or cordate-imbricate, narrowly lanceolate, ovate, broadly ovate or transversely broadly elliptic, terminating abruptly in long filiform, often uniseriate hair-like apex, entire or shallowly and irregularly crenulate or with a few long and/or short outgrowths at base. *Lamina* 43–197 mm long, elliptic to narrowly elliptic, 2-pinnate, with 7–21 pairs of pinnae. *Rachis* terete and rigid or distally shallowly sulcate, sparsely to densely set with naviculate trichomes and scales, adaxial scales similar in structure to those on abaxial surface. *Pinnae* 10–35 × 4.5–9.5 mm, opposite to approximate, proximally often alternate, distally alternate and closely spaced, often overlapping, mostly short-stalked throughout, narrowly ovate, adaxially glabrous, with naviculate trichomes or with few long ossiform-celled hairs, 0.9–2.7 mm long, or with small scales (similar to those on rachis); secondary rachis shallowly sulcate, distally winged, curves apically, abaxially sparsely to densely set with naviculate trichomes and scales; scales 0.5–3.1 × 0.4–0.9 mm, stramineous, cordate to cordate-imbricate, narrowly linear, triangular, lanceolate or ovate, crenulate or fimbriate. *Pinnules* opposite to alternate, 4–8 pairs per pinna, not or slightly overlapping, segments up to 3 pairs per pinnule, lobed, each terminating in 1 or 2 acute teeth. *Spores* stramineous, ridges widely spaced, ridges and grooves, granulate. *Chromosome number*: $2n = 152$. Figure 5L–T.

Diagnostic features

Mohria rigida is characterised by abaxially appressed, often broadly ovate, cordate-imbricate, often sinuous-walled scales, the crowded, caespitose frond arrangement, the rigid unwinged rachis, the often proximally unwinged secondary rachis, and sporangia generally borne on the entire frond or only the proximal pinnae may be sterile. In *M. rigida* the stipe/lamina ratio averages 1:2.45 ($n = 45$) whereas in *M. vestita*, with which this species may be confused, it averages 1:3.6 ($n = 61$). Clavate trichomes are 35.0–(45.76)–61.1 µm long and naviculate trichomes are 77.5–(112.86)–164.97 µm long.

Distribution and habitat

Mohria rigida is restricted to elevations of 1 800–2 438 m along the Drakensberg, the adjacent mountainous Lesotho and the Transvaal Highveld and escarpment (Figure 4). In the Drakensberg the plants usually occur individually or in small groups consisting of a few plants in the alpine and subalpine vegetation belts as defined by Killick (1963). Almost without exception they occur in seasonally moist, often exposed, rock crevices.

Variation

Variation occurs in frond and pinna length and in the density, size and outline of the scales on the abaxial and adaxial lamina surfaces. In *Mohria rigida* the stipe/lamina ratio ranges from 1: 0.84 to 1: 7.0 ($\bar{x} = 2.45$; $n = 45$).

Vouchers: *Roberts 3611* (PRE); *Roux 1013, 1075, 1904* (NBG); *Schweickardt s.n.* (PRE).

6. *Mohria vestita* Baker in Transactions of the Linnean Society, Botany 2: 328 (1887). Type: Tanzania,

Kilimanjaro, ad rupium fissuras, 6 000 ft. *Johnston s.n.* (K, holo!).

M. caffrorum (L.) Desv. var. *vestita* (Baker) F. Ballard: 561 (1954).

M. thurifraga sensu E.J. Lowe: 197, t. 70 (1860).

Lithophytic or terrestrial. *Rhizome* prostrate, short, up to 8 mm in diameter, irregularly branched, clothed with roots and scales; scales $1.7\text{--}6.3 \times 0.5\text{--}1.7$ mm, castaneous to ferrugineous, adnate, lanceolate to ovate, entire. *Fronds* erect, crowded, fertile ones generally longer than sterile

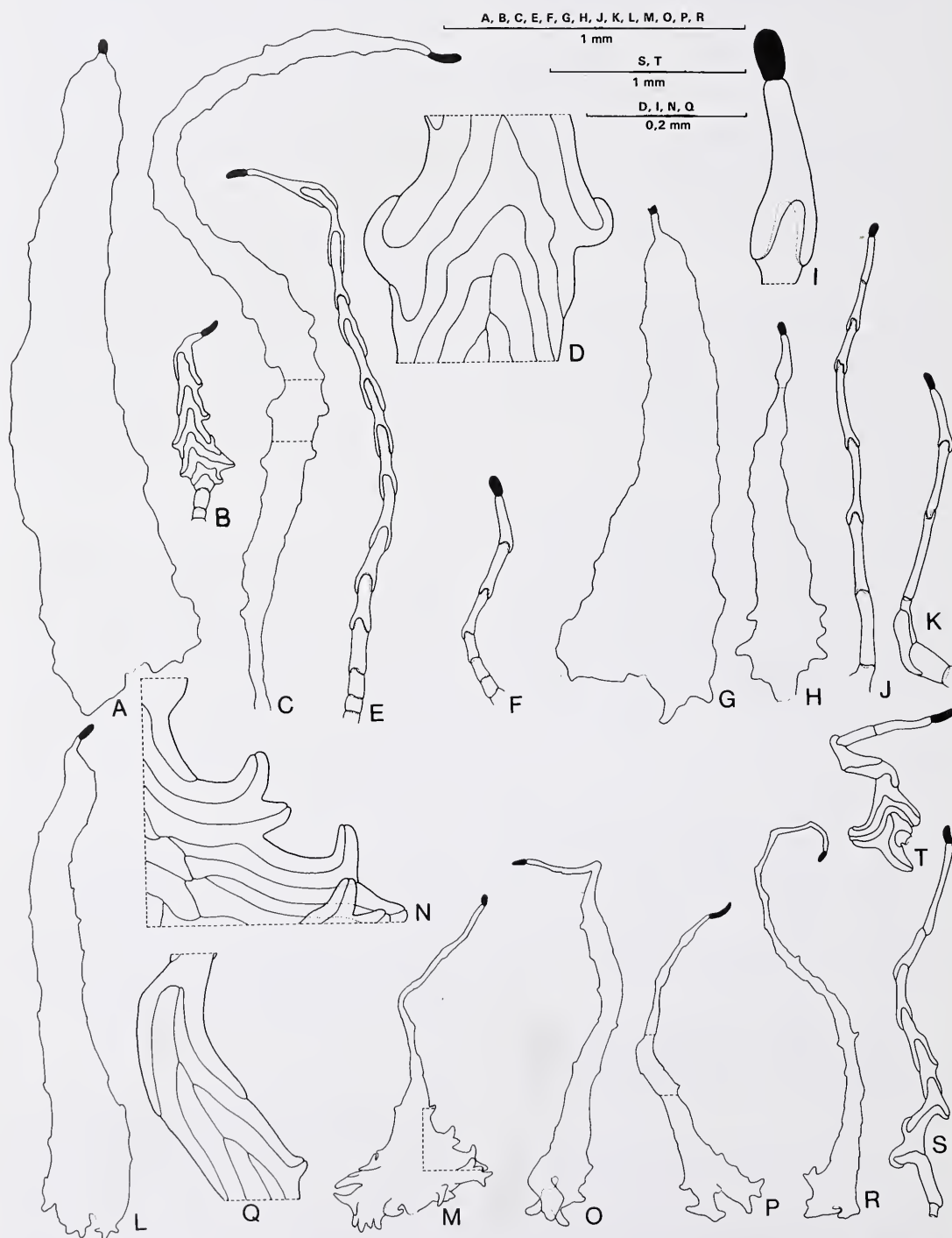


FIGURE 5.—Frond scales in *Mohria*. A–K, *M. saxatilis*, Roux 2002 (NBG). A–D, stipe; E, F, rachis; G–I, abaxial lamina surface; J, K, adaxial lamina surface. L–S, *M. rigida*, Roux 1910 (NBG). L, stipe; M, N, rachis; O–Q, abaxial lamina surface; R–T, adaxial lamina surface. Scale bars: A–C, E–H, J–M, O, P, R–T, 1 mm; D, I, N, Q, 0.2 mm.

ones; vernation non-circinate. *Stipe* terete, firm, proximally castaneous, distally stramineous, 20–132 mm long, up to 4 mm in diameter, with naviculate trichomes and scales becoming glabrous later; scales $0.5\text{--}6.8 \times 0.1\text{--}1.5$ mm, stramineous to castaneous, variable, cordate or cordate-imbricate, filiform or narrowly linear, shortly attenuate, hastate, or broad at base terminating abruptly in a long filiform apex, entire or with few short or long outgrowths at base curving apically. *Lamina* 53.5–380.0 mm long, herbaceous, sterile, narrowly elliptic, fertile, 79–464 mm long, narrowly oblanceolate, 2-pinnatifid to 2-pinnate, with 10–29 pairs of pinnae. *Rachis* proximally terete, distally shallowly sulcate and winged, sparsely to densely set with scales similar to those on abaxial lamina surface. *Pinnae* $8\text{--}44 \times 6.5\text{--}19.0$ mm, opposite to alternate, widely spaced proximally, distally crowded, often overlapping, ovate, proximally short-stalked, distally sessile; secondary rachis straight, winged throughout, shallowly sulcate adaxially, with clavate and naviculate trichomes and sinuous-walled and ossiform-celled hairs, $0.4\text{--}2.2$ mm long, abaxially sparsely to densely set with scales; scales $0.7\text{--}3.2 \times 0.1\text{--}0.7$ mm, castaneous, variable, filiform or adnate, linear and shortly attenuate, or cordate to cordate-imbricate, hastate to narrowly lanceolate, entire, irregularly crenulate or with short or long outgrowths at base, curving apically. *Pinnules* opposite to alternate, 4–9 pairs per pinna, generally not overlapping, segments up to 5 pairs, lobed, terminating in a single or paired, acute, often obtuse and falcate tooth. *Spores* stramineous, widely spaced ridges and grooves punctulate. *Chromosome number*: $2n = 152$. Figure 6A–L.

Diagnostic features

Mohria vestita is characterized by the short stipe/lamina ratio, the reduction in size of the pinnae towards the lamina base, ossiform-celled hairs which adaxially are confined to the secondary rachis and veins, and the relatively small, generally hastate and sparsely set twisted scales which are also confined to the secondary rachis and veins on the abaxial surface. Clavate trichomes are $30.0\text{--}(51.31)\text{--}63.4$ μm long and naviculate trichomes are $85.0\text{--}(138.32)\text{--}196.54$ μm long.

Distribution and habitat

The distribution of *Mohria vestita* ranges from the southern Cape along the central mountain ranges as far north as Kenya. It also occurs on the higher lying areas of Angola and in Madagascar (Figure 7). *M. vestita* grows in habitats ranging from coastal subtropical conditions to elevations exceeding 3 000 m along the Natal Drakensberg. On Mount Kilimanjaro, *M. vestita* has been recorded at elevations ranging from 1 200–1 400 m and at Humpata in Angola it occurs at 2 220 m. Fires are common throughout the distribution area of *M. vestita*, but appear to have no effect on the subterranean rhizome.

Variation

Variation in frond length can be ascribed to the wide distribution and diverse environmental conditions throughout the range. In hostile environments the fronds may be merely 109 mm long but at lower, more

favourable conditions the fronds may measure up to 690 mm. Irrespective of variation in frond length, a relationship exists between stipe and frond length in the sterile ($r = 0.683$, $P < 0.001$) and fertile ($r = 0.711$, $P < 0.001$) fronds. Variation in the density and distribution of indumentum is most apparent. Hairs on the adaxial and abaxial lamina surfaces appear to increase as the distribution extends to the north. Slight variation in the cell structure may also be evident.

Vouchers: *Daubenberger s.n.* (PRE); *Faden, Evans & Kabuye* 70/344A (BOL); *Janse* 106 (GRA, PRE); *Nicholas* 497 (SRGH); *Roux* 2233 (NBG).

7. *Mohria nudiuscula* J.P. Roux in South African Journal of Botany 56: 266 (1990a). Type: Natal, Weenen Division, damp streambanks in the Mnweni area, Drakensberg, *Esterhuysen* 14523 (NBG, holo.!; BOL, PRE, iso.!).

M. caffrorum (L.) Desv. var. *ferruginea* J.E. & S.M. Burrows in J.E. Burrows: 168 (1989). Type: Natal, (2929) Underberg: Drakensberg Mountains, Injasuti, below Women Grinding Corn, (–AB), *Burrows* 360 (BOL, holo.!; K. PRE, iso.).

Terrestrial. *Rhizome* prostrate, short, up to 10 mm in diameter, densely clothed with roots and scales; scales $4.7\text{--}6.9 \times 0.3\text{--}0.5$ mm, castaneous to ferruginous, adnate, narrowly lanceolate, entire. *Fronds* few, caespitose, spreading or erect, fertile ones slightly longer than sterile ones; vernation non-circinate. *Stipe* terete, firm, proximally castaneous, distally stramineous, 20–220 mm long, up to 3 mm in diameter, sparsely to densely set with naviculate trichomes and scales, becoming glabrous later; scales $0.5\text{--}7.5 \times 0.1\text{--}1.2$ mm, stramineous to castaneous, narrowly linear, narrowly lanceolate, triangular or hastate, terminating in a long filiform apex, entire, usually lignified at point of attachment. *Lamina* 53–635 mm long, often coriaceous, narrowly elliptic, pinnate to 2-pinnate, with 7–34 pairs of pinnae. *Rachis* shallowly sulcate for most of its length, densely set with naviculate trichomes and scales, similar but smaller than those along stipe. *Pinnae* $10\text{--}80 \times 6\text{--}15$ mm, proximally opposite to alternate, alternate and closely spaced distally, often overlapping, ovate to narrowly ovate, adaxially glabrous or with few naviculate trichomes and hairs, up to 1.8 mm long, often also with irregularly shaped filiform scales, up to 2.0×0.2 mm, along secondary rachis, abaxially with clavate and naviculate trichomes, and few or numerous scales; scales stramineous to castaneous, $0.4\text{--}3.2 \times 0.1\text{--}0.8$ mm, attenuate or hastate, filiform or narrowly lanceolate; secondary rachis straight, winged throughout, shallowly sulcate adaxially, sparsely to densely set with scales similar to those along rachis. *Pinnules* opposite to alternate, 3–12 pairs per pinna, basal pair often smaller than the next, distant to crowded and overlapping, lobed, segments up to 3 pairs per pinnule, margins slightly revolute, shallowly crenulate or obtusely toothed. *Spores* stramineous, broad ridges and deep narrow grooves sparsely to densely set with verrucae or spherical deposits, $70\text{--}90$ μm in diameter. *Chromosome number*: $2n = 152$ (Figure 6M–W).

Mohria nudiuscula was recently described by Burrows & Burrows in Burrows (1989) as *M. caffrorum* var. *ferruginea*. Unaware of this study, I described the same species as *M. nudiuscula* (Roux 1990a). However, when my manuscript

was in press, *M. caffrorum* (L.) Desv. var. *ferruginea* J.E. Burrows & S.M. Burrows was published. Although the latter name antedates *M. nudiuscula* I found it to be a distinct taxon and believe it not to be related to *M. caffrorum*. In accordance with Article 11.2 of the International Code of Botanical Nomenclature (1994) the name *M. nudiuscula* is adopted.

Diagnostic features

Diagnostic features in *Mohria nudiuscula* are the thick, coriaceous texture of the lamina, the often less dissected lamina, the shallowly crenulate or obtuse teeth and the almost glabrous adaxial lamina surface (hence the specific epithet). In most cases, however, a few long hairs, or small

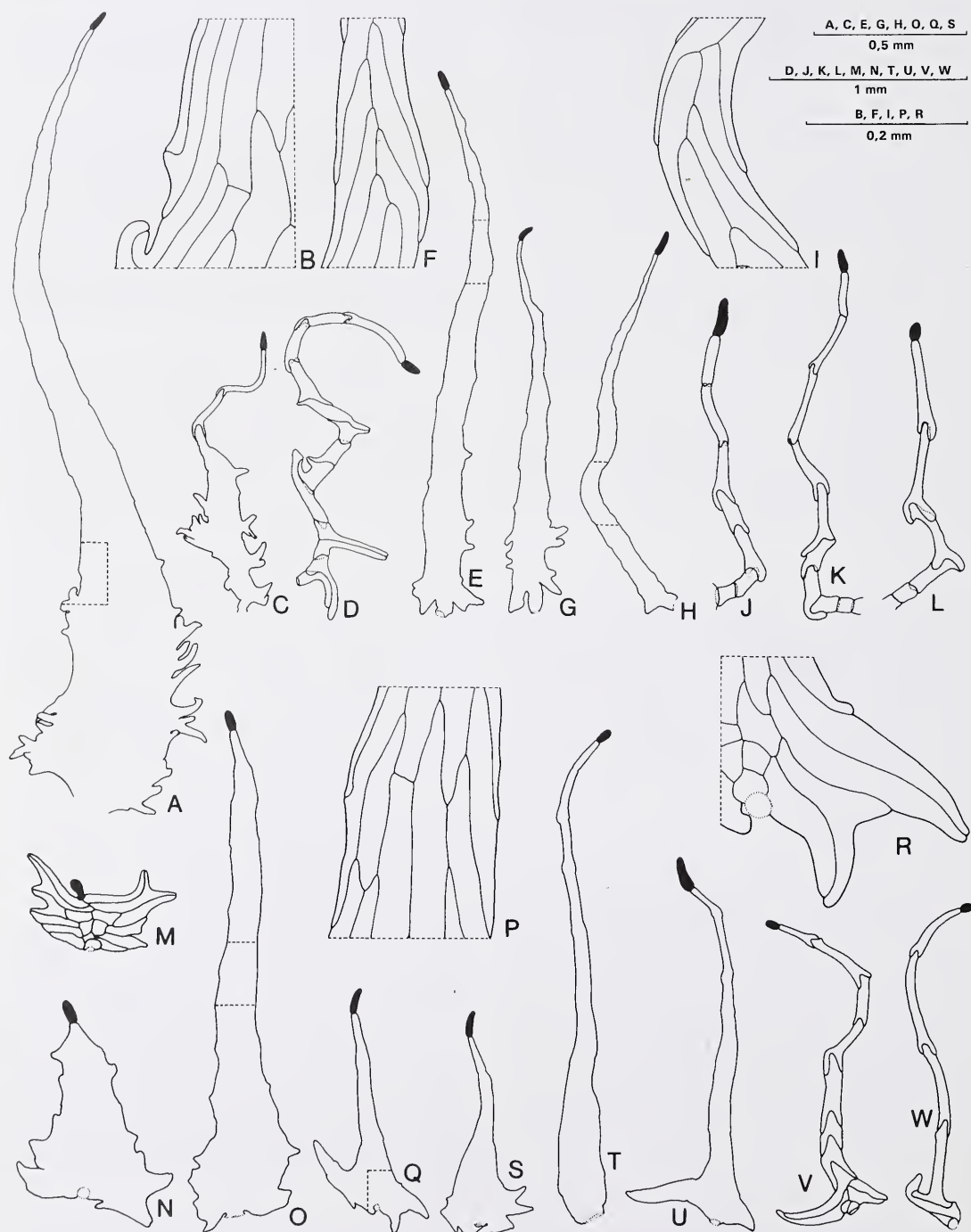
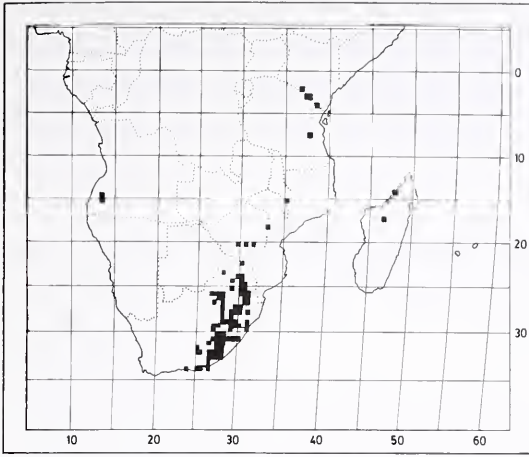


FIGURE 6.—Frond scales in *Mohria*. A–L, *M. vestita*, Roux 2219 (NBG). A–D, stipe; E, G, rachis; H–J, abaxial lamina surface; K, L, adaxial lamina surface. M–W, *M. nudiuscula*, Esterhuysen 14523 (NBG). M–P, stipe; Q–S, rachis; T, U, abaxial lamina surface; V, W, adaxial lamina surface. Scale bars: A, C, E, G, H, O, Q, S, 0.5 mm; D, J–N, T–W, 1 mm; B, F, I, P, R, 0.2 mm.

FIGURE 7.—Distribution of *Mohria vestita*.

scales, may occur adaxially along the secondary rachis; abaxially long filiform scales also occur along the veins on the stipe and rachis. Diagnostic micromorphological characters are the absence of stomata from the adaxial lamina surface, the presence of pericytic and paracytic stomata and the cuticular ridges occurring adaxially along the major veins (Roux *et al.* 1992). Clavate trichomes are 37.0–(50.5)–62.5 μm long and naviculate trichomes are 120.8–(156.4)–190.2 μm long.

Distribution and habitat

Mohria nudiuscula is largely confined to higher elevations with the distribution ranging from the Amatola Mountains in the Eastern Cape, along the KwaZulu-Natal Drakensberg, where this species has been recorded at elevations up to 2 400 m, and along the escarpment between the northeastern Orange Free State and KwaZulu-Natal. It is also widespread throughout the higher parts of Lesotho. Further north it occurs along the mountain ranges between Zimbabwe and Mozambique at elevations ranging up to 2 545 m, the Nyika Plateau in Malawi and the adjacent Rungwe Mountain range in Tanzania. In Zimbabwe, *M. nudiuscula* also occurs on serpentine-derived soils along the Great Dyke and as far west as the Victoria Falls (Figure 2). The habitat is subject to frequent burns which is evident from the fire scars borne by some collections.

Variation

When material throughout the distribution is viewed, an increase in frond length and pinna number becomes apparent towards the north. Fronds of plants occurring along the higher reaches of the Drakensberg are generally caespitose, firmly coriaceous and less dissected (2-pinnatifid) with the pinnae and pinnules crowded and overlapping. To the north, however, and especially along the mountains in eastern Zimbabwe, the fronds become erect and rigid. They are also more dissected (2-pinnate) with the pinnae and pinnules often distally spaced. The lamina texture along the northern limits of the distribution area also appears to be less coriaceous.

Vouchers: Brass 17286 (PRE, SRGH); Brunnitt & Synge 65 (SRGH); Last s.n. (K); Nicholson 97 (BOL); Roux 786 & 790 (NBG).

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Studies in the Marchantiales (Hepaticae) from southern Africa. 8. The genus *Plagiochasma* (Aytoniaceae: Aytonioideae) and six local taxa

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Keywords: Hepaticae, Marchantiales, *Plagiochasma appendiculatum*, *P. beccarianum*, *P. eximium*, *P. microcephalum* var. *microcephalum*, *P. rupestre* var. *rupestre*, *P. rupestre* var. *volkii*, southern Africa

ABSTRACT

A taxonomic account is given of the genus *Plagiochasma* Lehm. & Lindenb. and its two subgenera, *Micropyllum* Bischl. and *Plagiochasma*. The first subgenus is represented in southern Africa by *P. rupestre* var. *rupestre* (J.R. & G. Forst.) Steph. and *P. rupestre* var. *volkii* Bischl.; the second by *P. appendiculatum* Lehm. & Lindenb. (newly recorded for the region), *P. beccarianum* Steph., *P. eximium* (Schiffn.) Steph. and *P. microcephalum* (Steph.) Steph. var. *microcephalum*. Descriptions and illustrations of these taxa together with distribution maps and a key to the subgenera and species are provided.

UITTREKSEL

'n Taksonomiese verslag oor die genus *Plagiochasma* Lehm. & Lindenb. en sy twee subgenusse *Micropyllum* Bischl. en *Plagiochasma* word gegee. Eersgenoemde subgenus word in Suider-Afrika deur *P. rupestre* var. *rupestre* (J.R. & G. Forst.) Steph. en *P. rupestre* var. *volkii* Bischl. verteenwoordig en laasgenoemde deur *P. appendiculatum* Lehm. & Lindenb. (nuut vermeld vir die streek), *P. beccarianum* Steph., *P. eximium* (Schiffn.) Steph. en *P. microcephalum* (Steph.) Steph. var. *microcephalum*. Beskrywings en illustrasies van hierdie taksons sowel as verspreidingskaarte en 'n sleutel tot die subgenusse en spesies word verskaf.

***Plagiochasma* Lehm. & Lindenb.** in Lehm., Novarum et minus cognitarum stirpium pugillis quartus: 13 (1832); Nees: 33, 40 (1838); Gottsche et al.: 511 (1846); Steph.: 775 (1898); A. Evans: 262 (1915); Sim: 16 (1926); K. Müll.: 331 (1951–1958); Hässel de Menéndez: 83 (1963); S.W. Arnell: 65 (1963); Bischl.: 71 (1977); R.M. Schust.: 264 (1992). Type species: *P. cordatum* Lehm. & Lindenb.

Aytonia J.R. & G. Forst.: 147 (1776); Lindb.: 291 (1868); Schiffn.: 30 (1893). Type species: *A. rupestris*.

Aitonina J.R. & G. Forst.: 46, 73 (1787), orth. var. [not of Thunb.: 166 (1776)].

Rupinia L. f.: 69 (1781) nom. illegit.

Ruppinia L. f.: 204 (1783) orth. var. Type species: *R. rupestris*.

Antrocephalus Lehm.: 682 (1838). Type species: *A. nepalensis*.

Teldeia Mont. ex Webb & Berthel.: 59 (1840) nom. illegit. Type species: *T. elastica*.

Thalloid, smallish to medium-sized to large, flat to slightly concave, not grooved, firm and somewhat leathery, glaucous to purplish and then dull and waxy to velvety, or else bright green to yellowish green, dorsally hardly perceptibly areolate to distinctly so, in crowded, extensive mats, on calcareous soil, or in rocky crevices, on ledges, under overhangs, at foot of large boulders, at seepages or along stream

banks. *Branches* lingulate and simple to pseudodichotomously or variously furcate, with lateral or apical innovations from keel, sometimes articulated; thickened over midrib, thinning toward attenuate, narrowly purple, scalloped margins, apically notched, with scale appendages recurved over edge. *Dorsal epidermis* mostly lacking chloroplasts, thick- or thin-walled with trigones, roughened or smooth and with or without waxy, granular deposit externally. *Air pores* simple, sometimes \pm stellate, minute and very inconspicuous or larger and slightly raised, encircled by 1 ring or by 2(3) concentric rings of (4)5–8 cells in each, radial walls of cells often forming continuous lines which may be thickened, pores leading below into small, compact, empty air chambers in several irregular layers, bounding walls chlorophyllose, some scattered cells nearly filled with a single oil body, also present in storage tissue, where cells are closely packed; rhizoids ventral, some smooth, others pegged. *Scales* purple-red to violet, in 2 forwardly directed ventral rows, large, extending beyond thallus margins or not, basal portion broadly ovate, apically with 1 or 2(3) appendages, variable in shape, linear-lanceolate or ovate to orbicular, sometimes constricted or folded at base, containing a few scattered oil cells; scale margin entire or toothed and with papillae in subgenus *Plagiochasma*, but without in subgenus *Micropyllum*.

Monoicous, autoicous or parautoicous. *Androecia* with antheridia sunken in tumid, sessile, crescentic to broadly U- or V-shaped dorsal cushions, base encircled by short paleae. *Archegoniophores* dorsal, single to several acropetally arranged along length of leading branch, usually with tuft of slender paleae around base and eventually mostly at apex of very short to long unfurrowed stalk, bearing carpocephalum with (1)–2–4(–5) capsules, each on a short seta, capsule wall unistratose, cells lacking thickening bands, dehiscing by an irregularly decaying lid and

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covered by \pm spherical, bilabiate involucre with vertically slightly overlapping, somewhat swollen lips, top of carpocephalum slightly raised to nearly flat or somewhat depressed, 3- or 4-sided, with compound air pores. *Spores* 70–105 μm , yellow to brown, triangular-globular, winged, both faces coarsely reticulate, proximal face with distinct triradiate mark. *Elaters* 175–300 μm long, 7.5–20.0 μm wide in middle and tapering to ends, bi- or tri-spiral.

The genus *Plagiochasma* is classified in the family Aytoniaceae Cavers, and in the subfamily Aytonioideae, whereas the other four genera of the family, namely *Asterella*, *Cryptomitrium*, *Mannia* and *Reboulia* are placed

in subfamily Reboulinoideae Grolle (Grolle 1972). *Plagiochasma* was previously said to include \pm 34 species worldwide (Evans 1915), but the number of taxa has been considerably reduced by Bischler (1977, 1978, 1979). Most are confined to the rather warmer, dry regions of the world, although *P. rupestre* var. *rupestre* is nearly cosmopolitan. The other taxa that also occur in southern Africa, are more narrowly restricted in their distribution. Two subgenera, namely *Micropylum* and *Plagiochasma* have been instituted by Bischler (1977), based mainly on the compactness and colour of the thalli, the structure of the dorsal air pores and on the shape, size and margins of the scale appendages.

Key to subgenera and species of *Plagiochasma*

- 1a Thallus glaucous to greyish green, dull and velvety, dorsally granular, with numerous air pores, tiny and obscure, bounded by a single ring of 4–6 cells but never by an inner hyaline ring of collapsed cells; ventral scales with 1–2(3) narrow appendages, hardly or not constricted at base, with margins not differentiated and lacking teeth and/or papillae (subgenus *Micropylum* Bischl.):
 - 2a Ventral scales reddish pink to purple, rarely more than 2000 μm long, including pink, purple or hyaline appendage(s) (1 or 2), narrowly to broadly triangular, up to 900 μm long, apically shortly pointed, with 1 or 2 (rarely 3) cells in series, thin-walled and quadrate or rectangular; spores up to 92.5 μm in diameter 1a. *P. rupestre* var. *rupestre*
 - 2b Ventral scales dark red or purple, large, up to 3000 μm long, including hyaline appendage(s) (1–3), narrowly triangular, up to 1500 μm long, apically with a long point, with 3–5 elongated cells in series, thick-walled; spores more than 92.5 μm in diameter 1b. *P. rupestre* var. *volkii*
- 1b Thallus green to yellow-green, shiny and dorsally smooth with fewer air pores, large and quite conspicuous, raised and bounded by an inner hyaline ring of collapsed cells and then by 2 or 3 concentric rings of 5–8 cells in each; ventral scales with 1–3 appendages, wide or narrow, often constricted or folded at base with margins differentiated into smaller cells, teeth and/or papillae (subgenus *Plagiochasma*):
 - 3a Scales mostly with a single appendage, sometimes with two, round or oval or broadly triangular, widest across middle, constricted or folded at base; along margins 1 or 2 rows of regular, smaller cells or alternating with them cells of usual size, lacking teeth; elaters with evenly thickened spirals:
 - 4a Thallus robust; carpocephalum on short, thick stalk; scale appendage single, rarely double, rounded, large, hyaline above, red or pink below, markedly constricted at base; margins smooth, with small cells here and there alternating with somewhat larger ones 2. *P. appendiculatum*
 - 4b Thallus medium-sized; small carpocephalum on thin, short or long stalk; scale appendage single or double, oval or broadly triangular, pink or violet, slightly constricted or folded or horizontally pleated at base; margins with 1 or 2 rows of smaller, regular cells, occasionally with papillae 3. *P. microcephalum* var. *microcephalum*
 - 3b Scales with 1, 2 (or 3) appendages, narrowly triangular, slightly constricted to folded at base or evenly tapered; sometimes toothed along margins; elaters with spirals interrupted or evenly thickened:
 - 5a Thalli robust but carpocephala relatively small; dorsal air pores of thalli surrounded by hyaline ring and 3 concentric rings of cells; scale appendages red, not acuminate, slightly constricted or folded at base; elaters with spirals often interrupted 4. *P. eximium*
 - 5b Thalli less robust and carpocephala of usual size; air pores surrounded by hyaline ring and 2 concentric rings of cells; scale appendages purple, acuminate, lanceolate, not constricted at base; elaters with spirals evenly thickened 5. *P. beccarianum*

Subgenus *Micropylum* Bischl.

Micropylum is characterized by very compact, velvety thalli, the dorsal surface covered with a water-repellent, granular deposit and the numerous air pores tiny and inconspicuous; the ventral scales have acuminate appendages with undifferentiated margins, lacking teeth and papillae. *Plagiochasma rupestre* var. *rupestre* and *P. rupestre* var. *volkii* are placed here.

1. *Plagiochasma rupestre* (J.R. & G. Forst.) Steph. in Bulletin de l'Herbier Boissier, Sér. 1, Vol. 6.10: 783 (1898); K. Müll.: 332 (1952); A. Evans: 277 (1915); Sim: 18 (1926); Hässel de Menéndez: 84 (1963); S.W. Arnell: 67 (1963); Bischl.: 64 (1978); Volk: 237 (1979); Bischl. & Sérgio: 173 (1984); R.M. Schust.: 292 (1992). Type: Madeira, Funchal, Quinta do Bom Sucesso, *Sérgio* &

Nóbrega 3873 [LISU, neo.! selected by Bischl. & Sérgio (1984)]; PC; BM, G, MADJ, iso.).

P. abyssiticum Gola: 62 (1914). Type: Ethiopia, Erythraea, in regione Hamasen prope Asmara n. 132, 24. IV. 1909, leg. *Chiovenda*.

P. algericum Steph.: 780 (1898). Type: Algeria, leg. *Trabut*.

P. capense Sim: 17 (1926). Type: S Africa, Herschel, Cape Province, 5000 ft, leg. *Hepburn*.

P. dschallanum Steph.: 778 (1898). Type: Tanzania, Kilimandscharo, ad lacum Dschalla, leg. *Holst*.

P. muricatum Steph.: 310 (1901a). nom. illegit.

P. tenue Steph.: 779 (1898). Types: S Africa, Transvaal, leg. *MacLeod*, *Wilms*; Tanzania, Usambara, leg. *Holst*; Angola, leg. *Welwitsch*.

The above list of synonyms includes only African plants and was taken from Bischler (1978). Schuster (1992) gives an extensive list of \pm all synonyms established largely on the basis of detailed studies by Evans (1915) and Bischler (1978).

Thallus medium-sized to quite large, nearly flat to somewhat concave with the sides slightly raised, oblong to lingulate (Figure 1A), compact, glaucous to greyish green, dull, surface \pm water-repellent, narrow purple edge along margins, pores very inconspicuous, almost imperceptible as minute dots, subdorsal air chamber walls hardly visible, when wet; thallus margins incurved or clasped together, exposing deep purple to dull black, transversely striate underside of wings, toward apex sometimes covered with a dull bloom and medianly always by scales, when dry; in crowded, gregarious patches, simple or once, rarely twice furcate or with apical or latero-ventral innovations and then articulated or jointed. *Branches* 8–25 \times (3–)4–6 mm, 375–650 μ m thick over midrib, laterally thinning out into attenuate wings (Figure 1F); apex notched, with appendages of 8–10 deep pinkish purple or purple, sometimes partly decolorate scales recurved over edge; margins acute, thin, scalloped and undulate; flanks sloping obliquely, purple; ventral face medianly keeled, green, with row of purple-red or purple scales on either side (Figure 1E).

Dorsal epidermal cells unistratose, hyaline, polygonal, 5–7-sided, 25–47 \times 20–37 μ m, thin-walled but thickened at corners, in transverse section 25–37 μ m thick, externally covered with granules, occasionally containing an oil body, along margins cells rectangular (Figure 1I), \pm 27 \times 15 μ m, air pores numerous, 88–250 μ m distant from each other, not raised (Figure 1H), simple, tiny, mostly appearing plugged, but lacking small inner hyaline ring of collapsed cells, surrounded in one series by 3–5 small, bluntly triangular cells (Figure 1G), 10–20 μ m long, 17–25 μ m across widest part, partly overlying dorsal cells, radial walls often thickened. *Assimilation tissue* 175–220 μ m thick, \pm $\frac{1}{3}$ the thickness of thallus, air chambers empty, in several layers, vertical medianly, sloping obliquely toward the sides, 37–55(–125) μ m wide, cells in bounding walls rounded, rather irregular in size, but averaging 25 \times 22–25 μ m, some with oil bodies, these also present in storage tissue which occupies remaining $\frac{2}{3}$ thickness of thallus, cells angular, 25–32 μ m wide; rhizoids mostly pegged, 20–30 μ m wide, occasionally smooth, 17.5 μ m wide. *Scales* reddish pink or purple, occasionally with a faint bloom, appendages and base sometimes hyaline, arranged in 2 forwardly directed ventral rows, one on either side of midrib, rather asymmetric, obtusely triangular with flatly arched base, gradually narrowed above, without constriction into 1 (Figure 1K) or 2(3) (Figure 1J) acuminate to ovate-lanceolate appendages, margins entire, total length (including (600–)900–1450 μ m long appendage) 1200–3000 μ m, width at base (600–)900–1250 μ m, cells in body of scale 4–6-sided, 30–62(–75) \times 17–25 μ m, becoming smaller toward base and rectangular or not along margin, 30–40 \times 20 μ m, sometimes bulging outwards, where cells join, at apex ending in 1–4 uniseriate cells, scattered throughout scale several cells that had contained oil bodies, 20–37 \times 25 μ m.

Monoicous. *Androecia* in sessile cushions, round or crescentic, up to \pm 2 \times 3 mm, medianly on leading branch or on apical or latero-ventral innovations with immersed antheridia that open above via raised, 37.5 μ m high, conical papillae (Figure 1D), at base encircled by tapering, purple paleae (Figure 1N), up to 600 μ m long, 180 μ m

wide at base, cells 4- or 5-sided, \pm 50 \times 30–37 μ m, apical cell \pm 32 \times 20 μ m. *Archegoniophores* in acropetal sequence medianly along main branch, or paired on pseudodichotomously furcate branches, enclosed by tall tuft of tapering, purple-red paleae, up to 1500 μ m long, 220 μ m wide at base, most of them later carried to tip of stalk (Figure 1M), cells in body of paleae rectangular, 37–53 \times 20–25 μ m, toward apex elongating and narrowing, up to 62 \times 17 μ m, 3 or 4 serially arranged. *Carpoccephala* 2–3 mm wide, on top initially slightly raised (Figure 1B), later becoming depressed, air pores compound, with 1–3(–5) lobes, involucre lips vertical and swollen, slightly overlapping, each enclosing a single oval capsule, 1500 \times 1000 μ m, on a short seta and with decaying lid, wall unistratose, cells 25.0–37.5 \times 22.5–32.5 μ m, polygonal, thin-walled with corners thickened, lacking thickening bands (Figure 1L); stalk at maturity usually remaining very short, only rarely up to 6 mm long, lacking rhizoidal furrow, 640 \times 430 μ m in transverse section (Figure 1C), cortical cells thicker-walled externally, rounded, 17.5 \times 15.0 μ m, medullary cells thin-walled, angular, \pm 25 μ m wide. *Spores* 80–105 μ m in diameter, triangular-globular, polar, light brown to yellow brown, translucent, wing up to 12 μ m wide, margin undulate, crenulate; ornamentation similar on both faces: distal face (Figure 2A, F) with \pm 4 areolae across, \pm 20 μ m wide, areolar walls wide and studded with granules (Figure 2B, G); proximal face with narrow triradial mark, clearly elevated and distinct (Figure 2C), each of 3 facets with 6–9 areolae, up to 25 μ m wide, walls raised and wide, studded with granules (Figure 2D, H). *Elaters* light brown to yellow brown, 175–235 μ m long, 12.5 μ m wide in middle, tapering toward ends, \pm 5 μ m wide, bispiral (Figure 2E, I). *Chromosome number*: $n = 9, 18$ (Bischler 1978).

Two varieties are recognized: *P. rupestre* var. *rupestre* and *P. rupestre* var. *volkii*. They are distinguished by the longer, acuminate, hyaline appendages of the ventral scales and slightly larger spore dimensions of the latter.

1a. *P. rupestre* var. *rupestre*

Obliquely lunate ventral scales rarely longer than 2000 μ m and 1050 μ m across base; 1 or 2 narrowly to broadly triangular appendages up to 900 μ m long, 1.7–2.7 times longer than wide, and apically acuminate with uniseriate 1 or 2(3) terminal cells, quadrate or rectangular in shape and thin-walled; cells in curved margin of body of scale rectangular, sometimes bulging slightly outward where 2 cells join; male paleae around basal part of androecium 550–580 μ m long, 110–180 μ m wide at base, tapering to a narrow tip, with 1–3 cells in series, \pm 32 \times 20 μ m (Figure 1N); female paleae 1030–1375 μ m long, 150–220 μ m wide at base, tapering to a narrow tip, with up to 4 cells in series, 30–40 \times 17 μ m (Figure 1M); spores 80.0–92.5 μ m in diameter (Figure 2A, D).

The typical variety is subcosmopolitan and widely distributed, especially in xerothermic regions. Frey & Kürschner (1988) regard it as a xerothermic Pangaean taxon. In southern Africa it is quite common and frequently collected in rocky crevices, moist ledges, under boulders, or at seepages, on calcareous substrates or on soil overlying cave sandstone or dolomite. It sometimes grows together with *Targionia hypophylla*, *Athalamia*

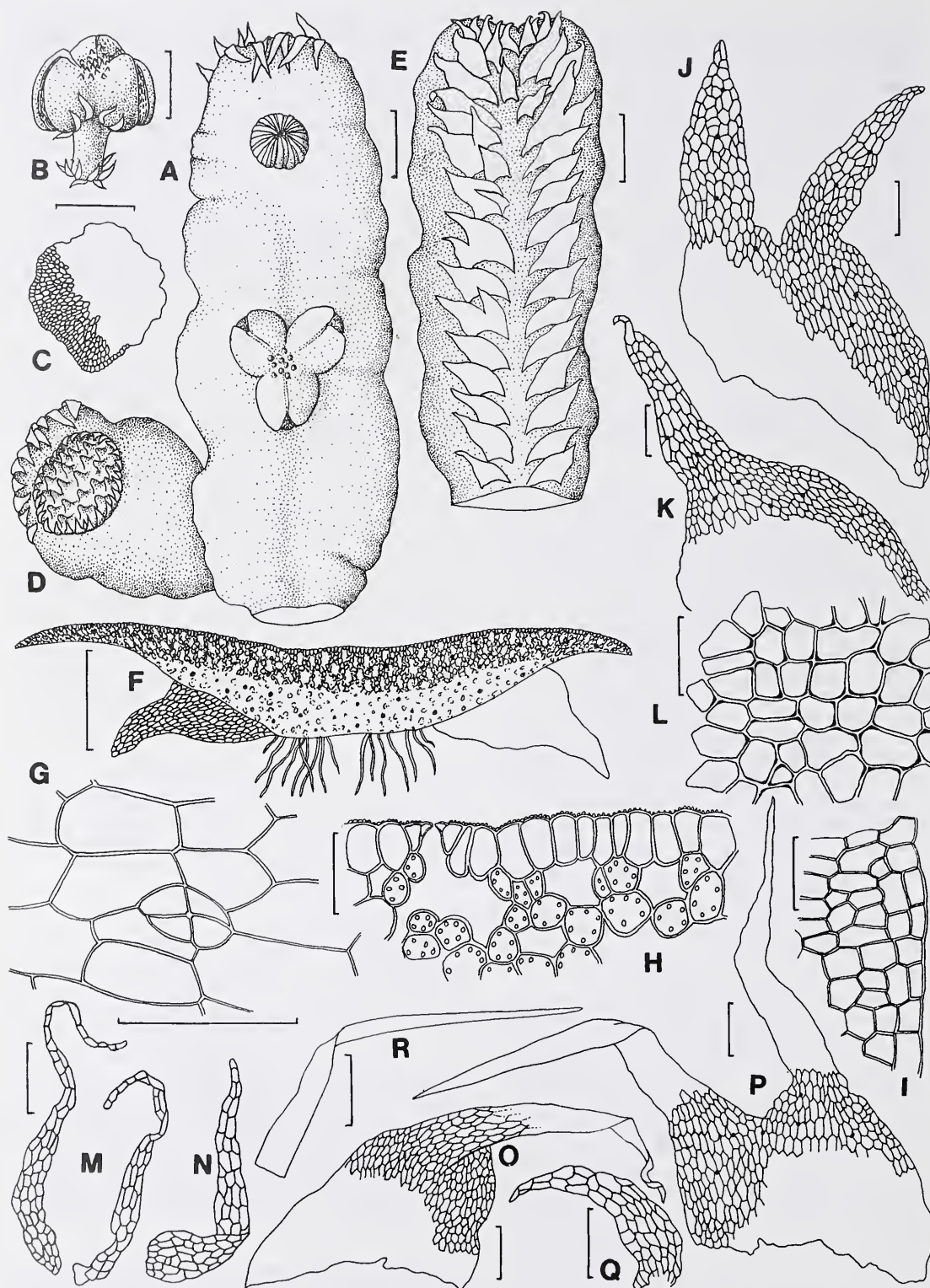


FIGURE 1.—A–N, *Plagiochasma rupestre* var. *rupestre*: A, E, F, I, thallus: A, dorsal face, with archegoniophore and carpocephalum; E, ventral face; F, t.s.; I, margin. B, carpocephalum, side view; C, t.s. of stalk; D, androecium at apex of latero-ventral branch; G, air pore and dorsal cells from above; H, t.s. of air pore, dorsal cells and air chambers. J, K, ventral scale: J, with 2 appendages; K, with 1 appendage. L, cells in capsule wall; M, female paleae; N, male palea. O–R, *Plagiochasma rupestre* var. *volkii*: O, P, ventral scale: O, with 1 appendage; P, with 2 appendages. Q, male palea; R, female palea. A, B, D, E, L, N, *Heilendorff* CH 13611; C, *Manning* CH 13590; F, H, *Anderson* 1230; G, I–K, M, *S.M. Perold* 3058; O–R, *Mogg* 37590. Scale bars: A, B, D, E, 2 mm; F, 1 mm; C, J, K, M–R, 250 μ m; G–I, L, 50 μ m.

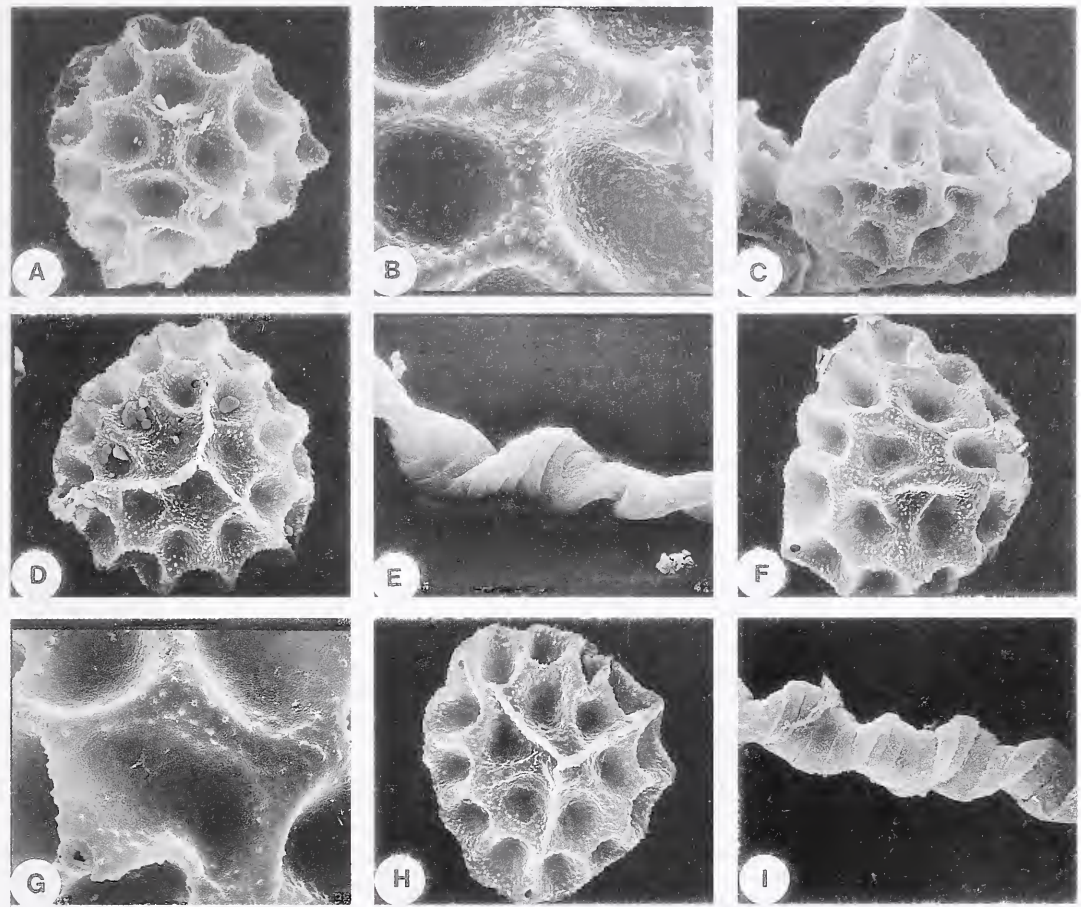


FIGURE 2.—SEM micrographs of spores and elater. A–E, *Plagiochasma rupestre* var. *rupestre*: A, distal face; B, much enlarged view of some areolae and walls on distal face; C, side view; D, proximal face; E, part of elater much enlarged. F–I, *P. rupestre* var. *volkii*: F, distal face; G, much enlarged view of some areolae and walls on distal face; H, proximal face; I, part of elater much enlarged. A, G.W. Sim CH 1145; B, neotype, Sérgio & Nobrega 3873; C, Volk 00639; D, Pole Evans 458; E, Cooper 962; F–I, Mogg 37590. A, $\times 452$; B, G, $\times 1150$; C, $\times 464$; D, $\times 440$; E, I, $\times 936$; F, H, $\times 402$.

spathysii and *Riccia* spp. It is known from Namibia, the Northwest, Northern and Eastern Transvaal, Gauteng (PWV), Orange Free State, Lesotho, KwaZulu-Natal, as

well as from Northern, Western and Eastern Cape (Figure 3). Its range in Africa extends northward into Zimbabwe from where it was also reported by Best (1990) and by Bischler (1978), who reported it from Kenya, Tanzania, Uganda, Ethiopia, Djibouti, Sudan, Chad, Morocco, Algeria and Angola, as well as from the islands of Madeira, Azores, Ascension, Cape Verde, St Helena and Réunion (Bischler 1990).

Plagiochasma rupestre var. *rupestre* is easily identified by its dull, velvety and glaucous thalli with simple, very inconspicuous pores and by its reddish pink or purple scales, with ovate-lanceolate or acuminate appendages, the margins of which are entire.

1b. *P. rupestre* var. *volkii* Bischl. Type: Namibia, Neudamm bei Windhoek, Volk 948 (JE).

Purple ventral scales larger (up to $3000 \times 1350 \mu\text{m}$) and more conspicuous than those of typical variety, especially 2 or 3 hyaline appendages, which are narrowly triangular, $1370\text{--}1450 \mu\text{m}$ long and 4 or 5 times longer than

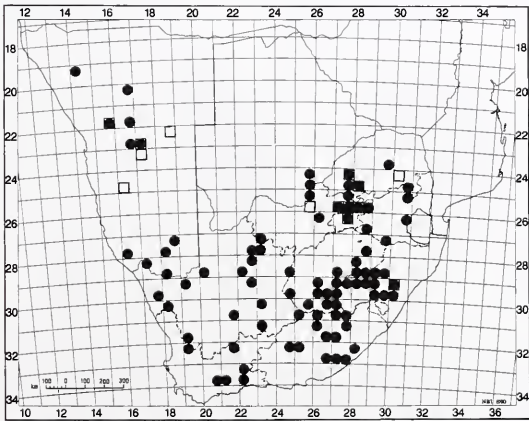


FIGURE 3.—Distribution of *Plagiochasma rupestre* var. *rupestre*, ●, and *P. rupestre* var. *volkii*, □, in southern Africa.

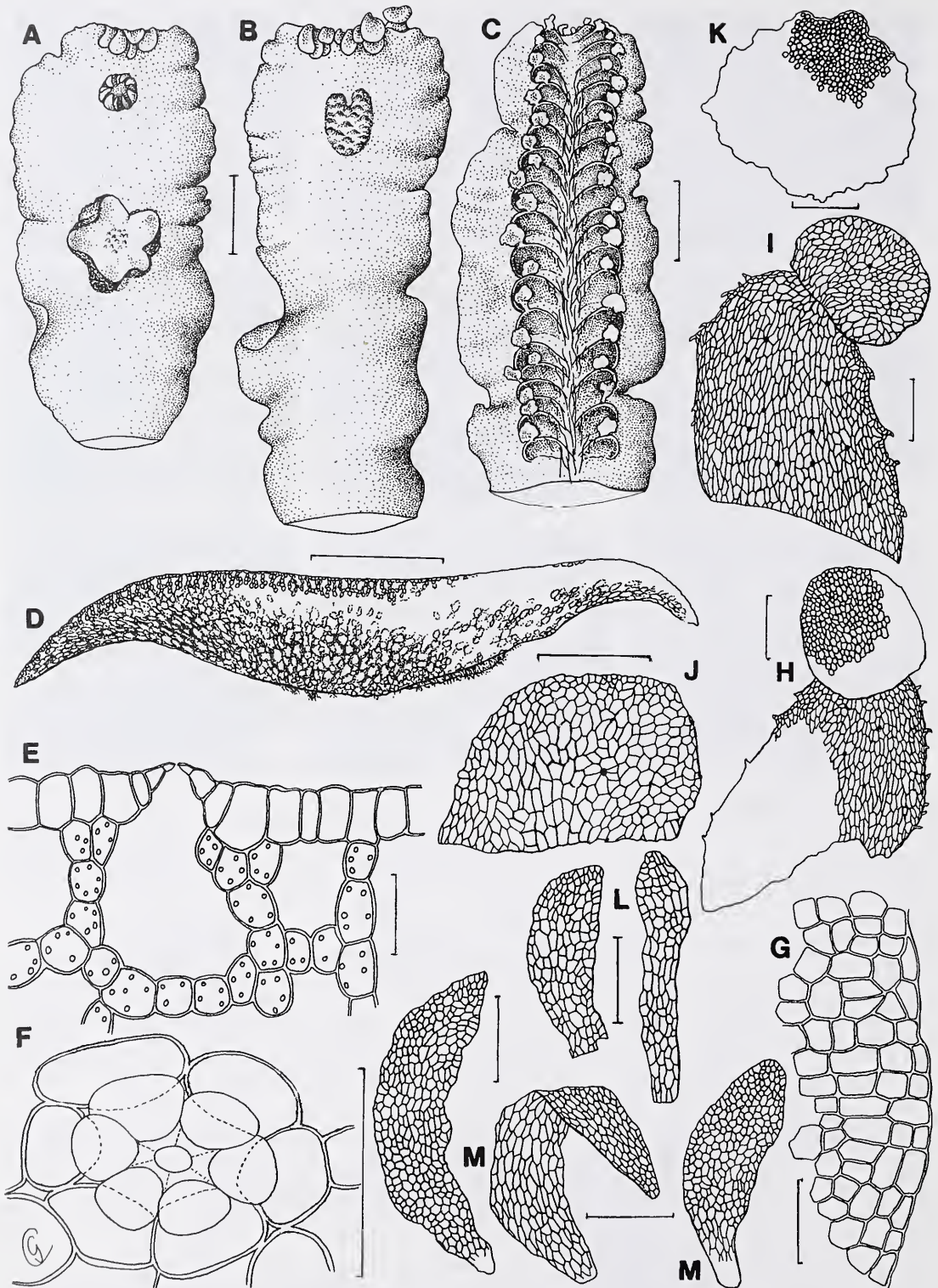


FIGURE 4.—*Plagiochasma appendiculatum*. A–D, thallus: A, dorsal face with archegoniophore and carpocephalum; B, dorsal face with androccium; C, ventral face; D, transverse section. E, transverse section of air pore, dorsal cells and air chambers; F, air pore and surrounding cells from above; G, margin of thallus; H, I, scales; J, scale appendage; K, transverse section of stalk; L, male paleae; M, female paleae. A, C, F, G, K, M, *Bottomley CH 268*; B, D, E, H–J, L, *S.M. Perold 854*. Scale bars: A–C, 2 mm; D, 1 mm; E, F, G, 50 μm; H–M, 250 μm.

wide (Figure 1O, P). Apex rather fragile, 3–5 elongated cells in series, walls thickened; cells at rounded margin of body of scale irregular in shape and size, cross walls often oblique; male paleae $\pm 600 \mu\text{m}$ long, $150 \mu\text{m}$ wide at base, tapering to a narrow tip where up to 4 cells, $50 \times 15 \mu\text{m}$, are in series (Figure 1Q); female paleae up to $1500 \mu\text{m}$ long, $100\text{--}150 \mu\text{m}$ wide at base, tapering to a narrow tip with 3 or 4 cells, $37.5\text{--}42.5 \times 12.5\text{--}17.5 \mu\text{m}$, in series (Figure 1R); spores (Figure 2F–H) $92.5\text{--}105.0 \mu\text{m}$ in diameter, slightly larger but very similar in appearance to those of typical variety.

This variety is quite rarely collected in southern Africa, but fairly frequently both varieties grow together. In the present investigation specimens of *P. rupestre* var. *volkii* from Namibia, the Northwest, Gauteng (PWV), Northern Transvaal, as well as KwaZulu-Natal have been examined (Figure 3). Bischler (1978) had also studied plants from the Western Cape, Orange Free State, Lesotho and Zimbabwe, so that it occurs throughout most of southern Africa. Schuster (1992) states that *P. rupestre* var. *volkii* also occurs in Peru and Argentina and it is thus not endemic to southern Africa.

In *P. rupestre* var. *volkii* the thallus is generally somewhat narrower than in the typical variety, but otherwise it is very similar in colour, appearance and composition. The very long, decolorate scale appendages are conspicuous, however, and make it easily separable.

Subgenus *Plagiochasma*

Most species are assigned to subgenus *Plagiochasma*, which is characterized by less compact green or yellow-green thalli, dorsally with quite large, raised air pores, surrounded by a hyaline ring and 2 or 3 concentric rings of (5)6–8 cells in each, radial walls generally forming continuous radiating lines that can be somewhat thickened; air chamber walls faintly visible from above and scale and appendage margins differentiated with smaller cells, teeth or papillae.

2. *Plagiochasma appendiculatum* Lehm. & Lindenb. in Lehmann, Novarum et minus cognitarum stirpium pugillus quartus: 14 (1832); Gottsche et al.: 517 (1844–1847); Steph.: 782 (1898); Kashyap: 318 (1914); Bischler: 228 (1978). Type: Nepal, Punjab, Dehra Doon, Wallich.

P. appendiculatum Lehm. & Lindenb. var. *erythraeum* Gola: 62 (1914). Type: Ethiopia, Eritrea, Hamasen, sul Monte Bizen nella valle Nabaret a Mai Electi, Ragazzi 253.

P. fischerianum (Steph.) Steph.: 786 (1898) (*P. fischeri*). Type: Kenya, Ligajio, Fischer 692 [as *Aitonina fischeriana* Steph.: 301 (1895)].

For a complete synonymy see Bischler (1978).

Thallus large, robust, flat with sides sometimes curved slightly downwards or upwards, broadly lingulate (Figure 4A, B), bright green, shiny, with narrow purple edge along margins, pores visible, small and slightly raised, when wet; thallus margins incurved or inflexed, exposing shiny, reddish purple to deep purple transversely striate and wrinkled underside of wings, not covered by scales, when dry; in crowded, gregarious patches, simple or once,

sometimes twice furcate, rarely jointed with apical or latero-ventral innovations. Branches $10\text{--}20 \times 5\text{--}8 \text{ mm}$, $750\text{--}925 \mu\text{m}$ thick over midrib, laterally thinning out into attenuate wings (Figure 4D); apex notched, with large orbicular reddish or partly hyaline scale appendages recurved over edge in 2 layers; margins acute, thin, scalloped and slightly undulate; flanks sloping very obliquely, reddish or purple; ventral face medianly keeled, green, with row of deep red or purple red scales on either side (Figure 4C). *Dorsal epidermal cells* unistratose, hyaline, \pm rectangular to polygonal, $22.5\text{--}42.5 \times 15.0\text{--}27.5 \mu\text{m}$, walls thin but thickened at corners, in transverse section $30.0\text{--}37.5 \mu\text{m}$ thick, smooth externally, along margins 2 or more rows of cells, rectangular, up to $25 \times 12 \mu\text{m}$ or shorter than broad, $\pm 15 \times 22 \mu\text{m}$ (Figure 4G); air pores not so numerous, $125\text{--}225 \mu\text{m}$ distant from each other, slightly raised (Figure 4E), simple, $7.5\text{--}10.0 \mu\text{m}$ wide, surrounded by an innermost ring, $\pm 2.5 \mu\text{m}$ wide, of tiny collapsed cells and then by 2 (occasionally partly by 3) concentric rings of larger cells, 5 or 6 inner ones transversely oval or round, $10\text{--}15 \times 15\text{--}20 \mu\text{m}$ (Figure 4F) partly overlying outer row of 5 or 6 bluntly triangular cells, $\pm 22.5 \times 30.0 \mu\text{m}$ across widest part, radial walls not thickened. *Assimilation tissue* $375\text{--}500 \mu\text{m}$ thick, $\pm \frac{1}{2}$ thickness of thallus, air chambers empty, in several layers, upper ones $\pm 25 \mu\text{m}$ wide, lower down wider, $\pm 62.5 \mu\text{m}$ wide, cells in bounding walls $30\text{--}45\text{--}(50) \times 22\text{--}37 \mu\text{m}$, some with a brown oil body, $25\text{--}30 \mu\text{m}$ wide; storage tissue occupying ventral $\frac{1}{2}$ of thickness of thallus, cells angular, up to $45 \mu\text{m}$ wide, with spaces between them, some smaller cells also with oil bodies; rhizoids either smooth, $12.5\text{--}25.0 \mu\text{m}$ wide, or pegged, $12.5 \mu\text{m}$ wide. *Scales* deep red, appendages mostly decolorate and sometimes base as well, arranged in 2 forwardly directed ventral rows, one on either side of midrib, asymmetric, obtusely triangular with flatly arched base, gradually narrowed above, deeply constricted and folded where joined with large, mostly single, orbicular appendage (Figure 4H, I), the latter up to $750 \mu\text{m}$ long, $550 \mu\text{m}$ across widest part in middle, $300\text{--}375 \mu\text{m}$ wide at base, at margin 1 or 2 rows of small rectangular cells $10.0\text{--}17.5 \times 7.5\text{--}12.5 \mu\text{m}$, alternating with somewhat larger cells, in centre of appendage toward base, cells large, rectangular, $\pm 75.0 \times 37.5 \mu\text{m}$, surrounded by several rows of irregularly shaped cells, variable in size (Figure 4J); body of scale up to $1250 \mu\text{m}$ long, $1100 \mu\text{m}$ across base, cells rectangular or 5-sided, $\pm 70 \times 25 \mu\text{m}$, 6 or 8 smaller, scattered ones with remains of oil bodies, $\pm 27.5 \times 20.0 \mu\text{m}$; at margins cells small, $\pm 25.0 \times 12.5 \mu\text{m}$, walls thin, curved, occasionally with long, projecting papillae.

Monoicous, but male and female receptacles often on separate plants. *Androecia* in sessile cushions, oval, horseshoe- or heart-shaped, $1.5\text{--}2.5 \times 2.0 \text{ mm}$, on leading branch medianly, near apex, proximally partly surrounded by shallow curved groove in thallus, base encircled by blunt, hyaline or partly purple paleae, $550\text{--}580 \times 130\text{--}180 \mu\text{m}$ (Figure 4L), cells rectangular or 5-sided, $\pm 57.5 \times 20.0 \mu\text{m}$, toward apex smaller, quadrate, $\pm 25 \times 25 \mu\text{m}$, near to base margins with some projecting papillae, $25.0 \times 12.5 \mu\text{m}$. *Archegoniophores* single or several in acropetal sequence medianly along main branch, initially enclosed by arching hyaline paleae, $\pm 850 \times 120 \mu\text{m}$ (Figure 4M), lower cells mostly rectangular, $40\text{--}45 \times 22 \mu\text{m}$, toward apex smaller, $\pm 20 \times 15 \mu\text{m}$ and at margin $15 \times$

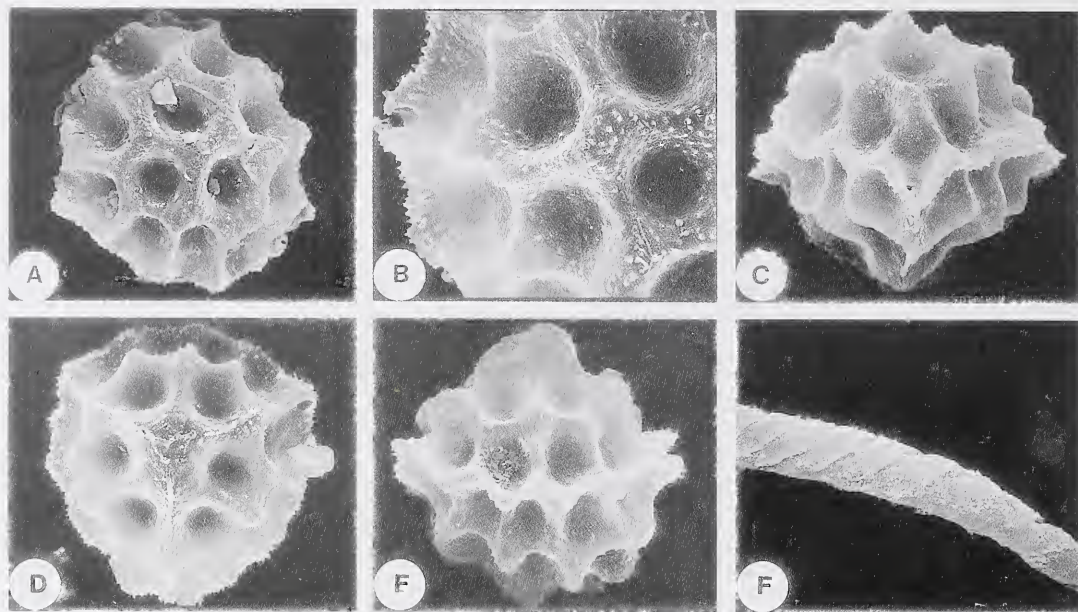


FIGURE 5—*Plagiochasma appendiculatum*. SEM micrographs of spores and elater. A–F A, distal face; B, much enlarged view of some areolae, walls, wing and pore on distal face; C, side view, distal face above; D, proximal face; E, side view, proximal face above; F, part of elater much enlarged. A, F, Hook 8204; B–E, S.M. Perold & M. Koekemoer 3135. A, $\times 511$; B, $\times 959$; C, $\times 577$; D, E, $\times 534$; F, $\times 940$.

25 μm , lacking papillae. *Carpoccephala* 2×2 mm when 4 lobes present, raised on stalk, 1.25–2.00 mm long, ± 750 μm in diameter (Figure 4K), in transverse section 1 or 2 rows of cortical cells, 17.5–27.5 \times 17.5–30 μm , medullary cells angular, up to 37.5 μm wide, thin-walled. *Spores* 75–85 μm in diameter, triangular-globular, polar, light brown, translucent, wing ± 10 μm wide, porate at corners, margin undulate, finely crenulate; ornamentation similar on both faces: distal face (Figure 5A–C) with 5 areolae across, ± 22 μm wide, walls finely granular; proximal face (Figure 5D, E) with very narrow triradiate mark, each of 3 facets with 6 or 7 areolae, walls wide and studded with granules. *Elaters* pale brown, 187–240 μm long, 10 μm wide in middle, tapering toward ends, 5 μm wide, bi- or tri-spiral (Figure 5F). *Chromosome number*: $n = 9$ (Bischler 1978).

After *P. rupestre*, *P. appendiculatum* was one of the earliest species in the genus to be described. It is generally a large plant and is easily recognized by its mostly single, very rarely double, large, orbicular scale appendages. Bischler (1978) examined a large number of specimens and found quite considerable variation in the size of the thallus and spores as well as in the thickness of the radiating cell walls at the air pores. In the present study only three southern African specimens were available for study; a fourth one is from Zimbabwe and was collected at Es-sexvale by Borle (also reported by Bischler), but the exact locality could not be traced. Three other specimens seen, were from elsewhere. *Plagiochasma appendiculatum* has not previously been reported from southern Africa, although it had been collected by Bottomley in 1930 at Pelindaba, the specimen being held at PRE. Unfortunately it was misidentified as a species of *Asterella* and was not sent on loan to Bischler, when she was revising the genus. Recently I have collected specimens of it twice (the

second time with M. Koekemoer) in Bakker's Pass, east of Thabazimbi in southwestern Northern Transvaal (Figure 6), where it grew between boulders in a shady, damp gully, together with *Fissidens* sp. and *Philonotis* sp. Ar-nell (1963) refers to *P. fischeri*, the synonym of *P. appendiculatum*, in his key to the species of *Plagiochasma*, but there is no description or illustration of the species.

Plagiochasma appendiculatum is chiefly an Asiatic species and has been reported from Afghanistan, Burma, Celebes, China, Taiwan [Formosa], India, Kashmir, Nepal, Pakistan, Philippines, Sikkim and Vietnam by Bischler (1978). She has also reported it from Yemen and Socotra as well as from Ethiopia, Kenya and Zimbabwe, where it is rare. Bizot *et al.* (1985) reported it as new from Tanzania and regard it as a palaeotropical species. Frey &

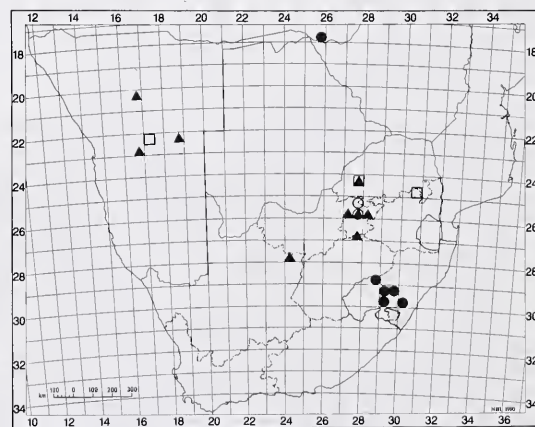


FIGURE 6.—Distribution of *P. appendiculatum*, \circ , *P. beccarianum*, \square , *P. eximium*, \bullet , and *P. microcephalum* var. *microcephalum*, \blacktriangle , in southern Africa.

Kürschner (1988) also reported it from the Arabian Peninsula and from Socotra; they assume that it is of xerothermic Pangaeic origin.

3. *Plagiochasma microcephalum* (Stepl.) Stepl. in Bulletin de l'Herbier Boissier, Sér. 1, Vol. 6.10: 781 (1898); Bischl.: 237 (1978); Volk: 240 (1979).

P. dinteri Stepl.: 762 (1901b). Type: Namibia (= Deutsch-Südwest-Afrika). Hereroland; Kransfontein, leg. *Dinter*.

Aitonia microcephala Stepl.: 301 (1895). Type: Tanzania, Usambara, leg. *Holst* 362 (G, holo.!).

Thallus smallish to medium-sized, flat to slightly concave medianly, with the sides somewhat raised or gently arching downwards, ligulate to oblong (Figure 7A), bright green, along margins red-brown to purple; finely and irregularly areolate, with pores faintly visible, when wet; thallus margins tightly inflexed, exposing shiny, deep purple or dark red transversely striate underside of wings, not covered by scales except partly toward apex, when dry; in crowded, gregarious patches, simple to several times pseudodichotomously furcate, occasionally with apical or latero-ventral innovations. *Branches* 6–12 × 3–4(–6) mm, 450–850 µm thick over midrib, laterally thinning out into attenuate wings (Figure 7E); apex notched with broadly ovate, purple or partly decolorate appendages recurved over edge; margins acute, thin, somewhat transversely pleated or crinkled, scalloped; flanks sloping obliquely, deep purple or dark red, ventral face medianly keeled, green, partly obscured by 2 rows of purple scales, one on either side (Figure 7B).

Dorsal epidermal cells unistratose, hyaline, 5- or 6-sided or polygonal, 22.5–35.0(–40.0) × 17.5–25.0 µm, rarely containing an oil body, walls thin, except at corners, where thickened and rounded with trigones, in transverse section 25.0–32.5(–37.5) µm thick, smooth externally, along margins generally 2 or 3(4) rows of ± quadrate or transversely rectangular cells, 12.5–20.0 × 12.5–25.0 µm (Figure 7H); air pores varying from not so numerous to numerous, distances between them (50–)100–185 µm, slightly raised (Figure 7F), simple, round or oval, 12.5 × 7.5–10.0 µm, surrounded by an innermost ring, ± 2.5 µm wide, of small collapsed cells and then by 2 concentric rings of 5–(7)8 cells in each (Figure 7G), inner cells transversely oval, 12.5–17.5 × 15.0–20.0 µm, partly overlying next row of bluntly triangular cells, 12.5–22.5 µm long, 25.0–32.5 µm across widest part, narrowing to base of ± 12.5 µm wide, radial walls sometimes thickened (Figure 7G). *Assimilation tissue* 200–400 µm thick, ± ½ thickness of thallus, air chambers empty, in several layers, upper ones smaller, 30–50 µm wide, lower down up to 85 µm wide, cells in bounding walls 20.0–37.5 × 27.5–35.0 µm, some with a spherical oil body almost filling cell; storage tissue occupying ventral ½ of thickness of thallus, cells angular, closely packed, 35.0–52.5 × 35.0–42.0 µm, a few scattered ones also containing an oil body; rhizoids either smooth, 17.5–25.0 µm wide, or pegged, 12.5–17.5 µm wide. *Scales* and appendages purple or reddish or partly decolorate, arranged in 2 forwardly directed ventral rows, one on either side of midrib, asymmetric, obliquely triangular with base hardly arched, narrowed above into 1 (Figure 7J) or sometimes 2 (Figure 7I) broadly ovate or triangular appendages (Figure 7K, L), equal in size or not, 350–600 µm long, 350–450 µm across mid-

dle, constricted or folded or transversely pleated at base where joined to rest of scale, cells toward centre quadrate or rectangular and fairly regular, 25.0–40.0 × 22.5–37.5 µm, apically small and blunt, 10 × 10 µm, 1 or 2 rows along margins ± 17.5 × 20.0 µm, some transversely rectangular, ± 15 × 35 µm, thinner-walled, occasionally with an outwardly projecting papilla; body of scale up to 675 µm long, 800–1500 µm across base, cells 4–6-sided, 37.5–70.0 × 25.0–30.0 µm, ± 10 with remains of oil body, 42.5 × 32.5 µm, cells smaller and thinner-walled toward margins, sometimes curved or bent, a few with projecting papilla.

Monoicous. *Androecia* in small sessile cushions, rounded or V-shaped, ± 1 mm wide, medianly along length of thallus and alternating with archegoniophores, occasionally paired at pseudodichotomy of branches, antheridia opening above via prominent papillae, basally cushions encircled by shallow groove in thallus and surrounded by inconspicuous purple paleae that taper slightly toward apex (Figure 7M), ± 400 × 200 µm, cells 32.5–37.5 × 15.0–20.0 µm, several mucilage papillae projecting along margins and from apex. *Archegoniophores* acropetally arranged along length of thallus and alternating with androecia, enclosed by arching, hyaline or purple paleae, ± 500 × 150 µm, tapering toward apex (Figure 7N), cells rectangular, 35.0–45.0 × 17.5–22.5 µm, sometimes with a few mucilage papillae at margins. *Carpoccephala* small, 1.0 × 2.0 mm, when 2 lobes present (Figure 7C), raised on stalk, up to 15 mm long and variously twisted, striate and dark red, ± 310 µm in diameter, in transverse section (Figure 7D) cortical cells in 1 row, thick-walled externally and rounded, 12.5–17.5 × 12.5–15.0 µm, medullary cells thin-walled, angular, 12.5–17.5 µm wide. *Spores* 70–75 µm in diameter, triangular-globular, polar, light brown, translucent, wing ± 10 µm wide, pore at corners occasionally present, margins undulate, finely crenulate, ornamentation similar on both faces: distal face (Figure 8A, B) with 4 areolae across, 15–20 µm wide, walls narrow, only ± 2.5 µm wide, almost smooth to granular; proximal face with distinct triradiate mark, arms thin, 5.0–7.5 µm high, 4 areolae on each of 3 facets, walls almost smooth (Figure 8C–E) to granular. *Elaters* light brown, 212–300 µm long, 7.5 µm wide in middle, tapering toward ends, ± 5.0 µm wide, bi- or trispiral (Figure 8F). *Chromosome number*: n = 9 (Bischler 1978).

Bischler (1978) recognized two varieties of *P. microcephalum*, namely var. *microcephalum* and var. *tunesicum* Bischl. The latter appears to be restricted to Tunisia, whereas she reported the former from the following African countries: Ethiopia, Uganda, Angola, Namibia and South Africa. It is also known from Madagascar, Yemen and southwest India. In the present investigation, a few more specimens from Northern Transvaal, Gauteng (PWV), the Northwest and Northern Cape have been identified (Figure 6). It can be distinguished by the green colour of the fresh thallus and by the generally large, broadly ovate or triangular scale appendages which have one or two rows of smaller cells along the margin. Bischler (1978) reported that plants growing in dry habitats have scales with a single, broadly ovate appendage which is constricted at the base, whereas those from more humid sites usually have one or two triangular

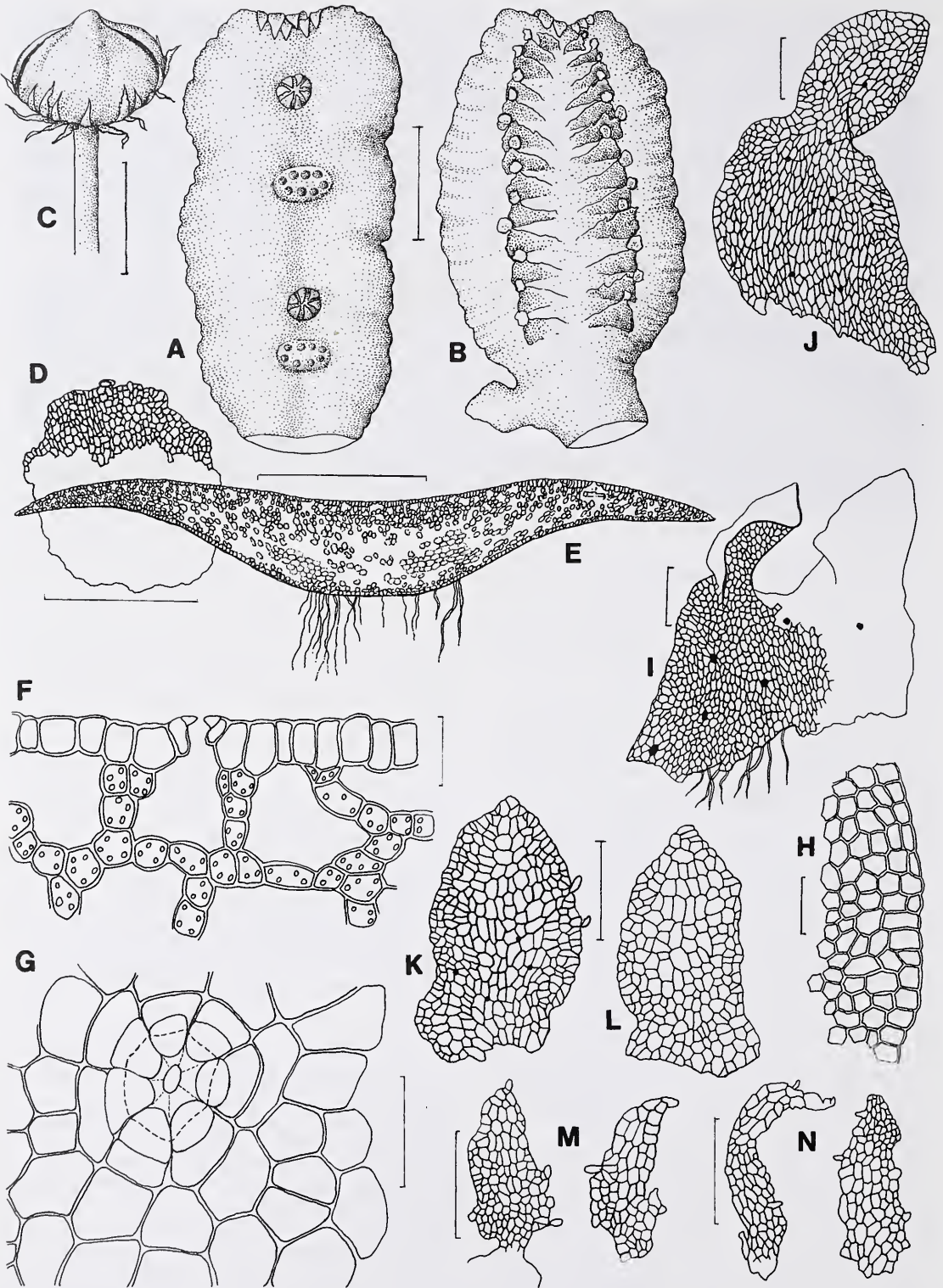


FIGURE 7.—*Plagiochasma microcephalum* var. *microcephalum*. A, dorsal face of thallus with young receptacles; B, ventral face of thallus; C, carpocephalum on stalk; D, transverse section of stalk; E, transverse section of thallus; F, transverse section of air pore, dorsal cells and air chambers; G, air pore and dorsal cells from above; H, margin of thallus; I, scale with 2 appendages; J, scale with single appendage; K, L, scale appendages; M, male palcae; N, female palcae. A, B, F, G, *Condy* 47; C, D, *Holst* 362; E, *S.M. Perold* 2976; H–K, M, N, *Bottomley* CH 175; L, *Burt Davy* 15176. Scale bars: A–C, E, 1 mm; D, 100 μm; F–H, 50 μm; I–N, 250 μm.

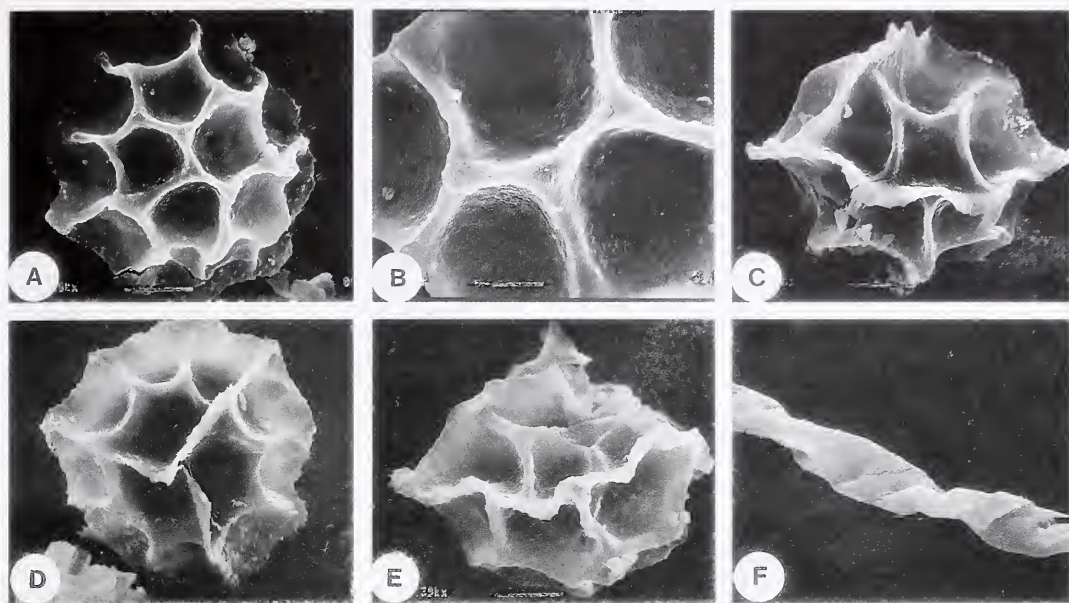


FIGURE 8.—*Plagiochasma microcephalum* var. *microcephalum*. SEM micrographs of spores and elater. A, distal face; B, much enlarged view of some areolae and walls on distal face; C, E, side view; D, proximal face; F, part of elater much enlarged. A–F, *Holst* 362. A, $\times 600$; B, $\times 1357$; C, $\times 679$; D, $\times 585$; E, $\times 647$; F, $\times 940$.

scale appendages horizontally folded at the base and hardly constricted. My observations appear to confirm this.

This species is equally well adapted to dry or to damp habitats. It grows in dry river beds between limestone boulders or on granite hills or on damp stream banks, but has not been frequently collected. Plants with mature female receptacles are rare. The carpocephala are small (hence the specific epithet) and are raised on a slender, short or long, dark red stalk.

Frey & Kürschner (1988) regard it as a palaeotropical taxon with a tropical African distribution. Sim (1926) stated that *P. dinteri* [placed in synonymy under *P. microcephalum* by Bischler (1978)] was not known to him and he quoted a few particulars from Stephani (1901b). Arnell's (1963) description of *P. dinteri* contains several inexactitudes as already observed by Bischler (1978): thallus dimensions '15 cm long and 16 mm wide; peduncle apical, spores 40–50 μm in diameter, without a wing or with a rudimentary one, occasionally with a wing up to 4 μm wide; surface irregularly areolate'. One of the specimens seen by him [Essendale (sic)] is the Borle collection from Essexdale and belongs to *P. appendiculatum*. The collection from Hennops River, of which he illustrates the spores, has not been traced. The Holst specimen (the type of *P. microcephalum*) was seen by Arnell and under *P. tenue* he states that it belongs to another species, which is certainly correct, since *P. tenue* is a synonym of *P. rupestre*, but he failed to notice the similarity between *P. microcephalum* and *P. dinteri*.

4. *Plagiochasma eximium* (Schiffn.) Steph. in Bulletin de l'Herbier Boissier, Sér. 1, Vol. 6.10: 781 (1898); Bischl.: 248 (1978).

P. schimper Steph.: 788 (1898). Type: Ethiopia (Abyssinia). In monte Semen, leg. Schimper.

Aiton *eximia* Schiffn. in Steph.: 300 (1895). Type: Kamerun, Buea, an den Höhlen eine Stunde östlich von Manus-Quelle, 2 500 m, 4-II-1891, leg. Preuss 731 (FI, lecto!).

Grimaldia abyssinica Gola: 63 (1914). Type: Abyssinia, leg. *Chioevda* 2993 (FI).

Thallus large, robust, \pm flat to sometimes medianly concave with sides raised or slightly incurved, broadly ovate (Figure 9B) to lingulate (Figure 9C), yellow green, along margins narrowly to widely dark red; finely and irregularly areolate with pores slightly raised, when wet; thallus margins tightly inflexed or incurved, exposing shiny, dark red, somewhat wrinkled and transversely striate underside of wings, ventrally covered in wine red or deep pink scales, when dry; in crowded, gregarious patches, simple or once pseudodichotomously furcate (Figure 9A), sometimes with one or more apical innovations and articulated (Figure 9B). Branches 16.5–22.0 \times 5.0–8.5 mm, \pm 750 μm thick over midrib, laterally thinning out into attenuate wings (Figure 9E); apex notched with lanceolate, reddish pink or dark red scale appendages recurved over edge; margins acute, thin, scalloped and undulate; flanks sloping obliquely, dark red, ventral face medianly keeled, green, with a row of deep red scales on either side (Figure 9C).

Dorsal epidermal cells unistratose, hyaline, oblong, ovate or polygonal, walls with trigones at corners, 25–40 \times 20–35 μm , in transverse section 30.0–37.5 μm thick, smooth externally, along margins 2(3) rows of cells (Figure 9H), rectangular, 25–35 \times 10–20 μm , or shorter than broad, \pm 17.5 \times 35.0 μm ; air pores not numerous, distances between them variable, 230–440 μm , slightly raised (Figure 9F), simple, round or oval, 12.5–27.5 \times 15.0–27.5 μm , surrounded by an innermost ring, \pm 7.5 μm wide, of

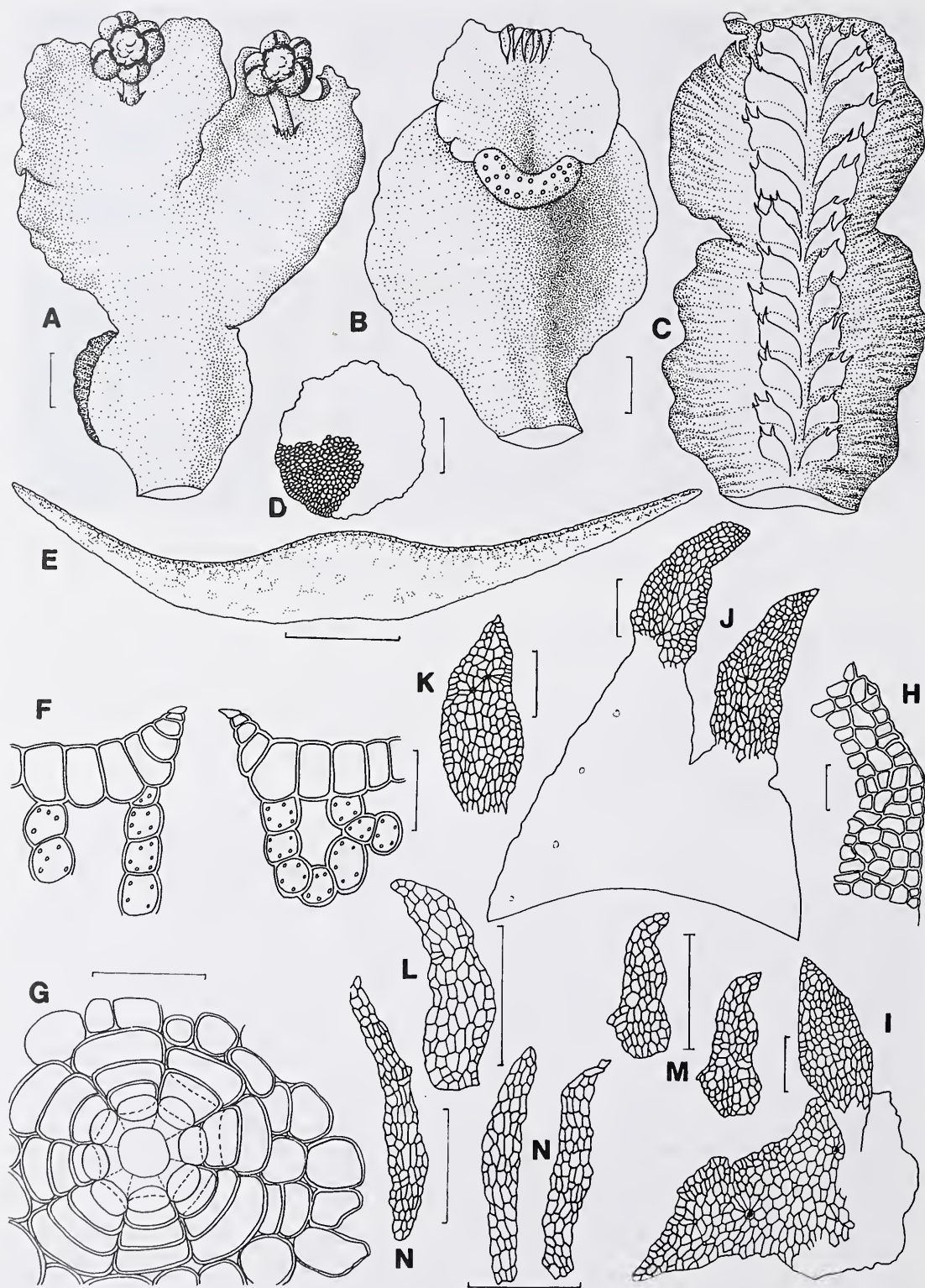


FIGURE 9.—*Plagiochasnia eximium*. A, thallus with 2 carpocephala; B, thallus with androecium; C, ventral face of thallus; D, transverse section of stalk; E, transverse section of thallus; F, transverse section of air pore, dorsal cells and air chambers; G, air pore and dorsal cells from above; H, margin of thallus; I, scale with single appendage; J, scale with 2 appendages; K, scale appendage; L, M, male palaeae; N, female palaeae. A–C, L, *S.M. Perold* 2498; D–I, N, *Sim* CH 1163; J, K, *H. Anderson* CH 4498; M, *Sim* CH 1200. Scale bars: A–C, 2 mm; D, 100 μ m; E, 1 mm; F–H, 50 μ m; I–N, 250 μ m.

small collapsed cells and then by 3 concentric rings of 7 or 8 larger cells in each (Figure 9G), inner cells transversely oval, $\pm 12.5 \times 17.5 \mu\text{m}$, partly overlying next row of transversely oblong cells, $\pm 12.5\text{--}15.0 \times 25.0\text{--}32.5 \mu\text{m}$, outermost ring of cells $\pm 17.5 \times 40.0\text{--}45.0 \mu\text{m}$, radial walls sometimes thickened. *Assimilation tissue* 375–475 μm thick, $\pm \frac{1}{2}$ or more than $\frac{1}{2}$ thickness of thallus, air chambers empty, in several layers, upper ones $\pm 35 \mu\text{m}$ wide, lower down $\pm 110 \mu\text{m}$ wide, cells in bounding walls 22.5–27.5 \times 25.0–27.5 μm , gradually enlarging to 42.5 \times 32.5 μm , some with spherical dark brown oil body, $\pm 32.5 \mu\text{m}$ in diameter, almost filling cell, these also present in storage tissue, which occupies ventral part of thallus, cells angular, up to 37.5 μm wide; rhizoids some smooth, 12.5–17.5 μm wide, others pegged, 10.0–17.5 μm wide. *Scales* and appendages deep pink to wine red, arranged in 2 forwardly directed ventral rows, one on either side of midrib, asymmetric, obtusely triangular with arched base and narrowed above into 1 (Figure 9I) or 2 (Figure 9J) and sometimes 3 tapering appendages, 650–900 μm long, slightly constricted or pleated at base (Figure 9K), 250–350(–400) μm wide, cells long-rectangular or hexagonal, 37.5–55.0 \times 20.0–25.0 μm , apex not acuminate but often unicellular, 20.0–30.0 \times 20.0–27.5 μm ; body of scale $\pm 950 \mu\text{m}$ long, 1650 μm across base, cells 4–6-sided, 37.5–62.5 \times 27.5–35.0 μm , ± 14 with remains of oil body, scattered and smaller, 25.0 \times 22.5 μm , at margins cells narrowly rectangular, $\pm 22.5 \times 10.0 \mu\text{m}$, occasionally with a projecting papilla, 15 \times 15 μm .

Monoicous, but male and female receptacles sometimes on separate plants. *Androecia* in sessile cushions, kidney- or sausage-shaped, 1 mm wide, medianly at base of smaller articulated, apical innovation (Figure 9B) of leading branch, proximally partly surrounded by shallow curved groove in thallus, encircled by apically tapered,

dark red paleae, 250–500 \times (90–)100–120 μm , cells rectangular, 40–55 \times 17–20 μm , smaller toward apex, 32.5 \times 15.0 μm , and along upper part of margin 25.0–37.5 \times 12.5–15.0 μm , sometimes with a projecting papilla supported on a narrow base and also above at apex. *Archegoniophores* single or occasionally paired when branches bifurcate (Figure 9A), medianly near apex of branch, enclosed by arching, hyaline paleae, $\pm 550 \times 80 \mu\text{m}$, tapering toward apex with single cell, $\pm 22.5 \times 12.5 \mu\text{m}$, lower down cells larger, rectangular, up to 42.5 \times 15.0 μm , margins sometimes with a papilla. *Carpoccephala* 3.25 \times 3.25 mm, when 4 lobes present, raised on stalk, 3–6(–9) mm long, striate and dark red, in transverse section (Figure 9D) $\pm 850 \times 750 \mu\text{m}$, cortical cells in 1 row, $\pm 20.0 \times 17.5 \mu\text{m}$, thick-walled externally, medullary cells thin-walled, angular, up to 37.5 \times 30.0 μm . *Spores* 82.5–90.0 μm in diameter, triangular-globular, polar, golden brown, translucent, wing up to 12.5 μm wide, porate at corners, margins undulate, finely crenulate; ornamentation similar on both faces: distal face (Figure 10A–C) with 4 or 5 areolae across, 22.5–32.5 μm wide, walls wide and finely granular; proximal face (Figure 10D, E) with distinct triradiate mark, arms $\pm 5 \mu\text{m}$ high, mostly 4 shallow areolae on each of 3 facets, walls sparingly sprinkled with granules. *Elaters* light brown, 175–225 μm long, 15–20 μm wide in middle, tapering toward ends, 5.0–7.5 μm wide, laxly bispiral or spirals interrupted (Figure 10F). *Chromosome number*: $n = 9$ (Bischler 1978).

Plagiochasma eximium has previously been reported from southern Africa by Bischler (1978), who had examined a specimen, *Sim CH 1163*, from Mont-aux-Sources which had earlier been identified as *P. rupestre*. Two other specimens, *Sim CH 1200* (Pietmaritzburg) and *Sim CH 1186* (Victoria Falls), have now been identified as *P. eximium*, as well as some later collections from the

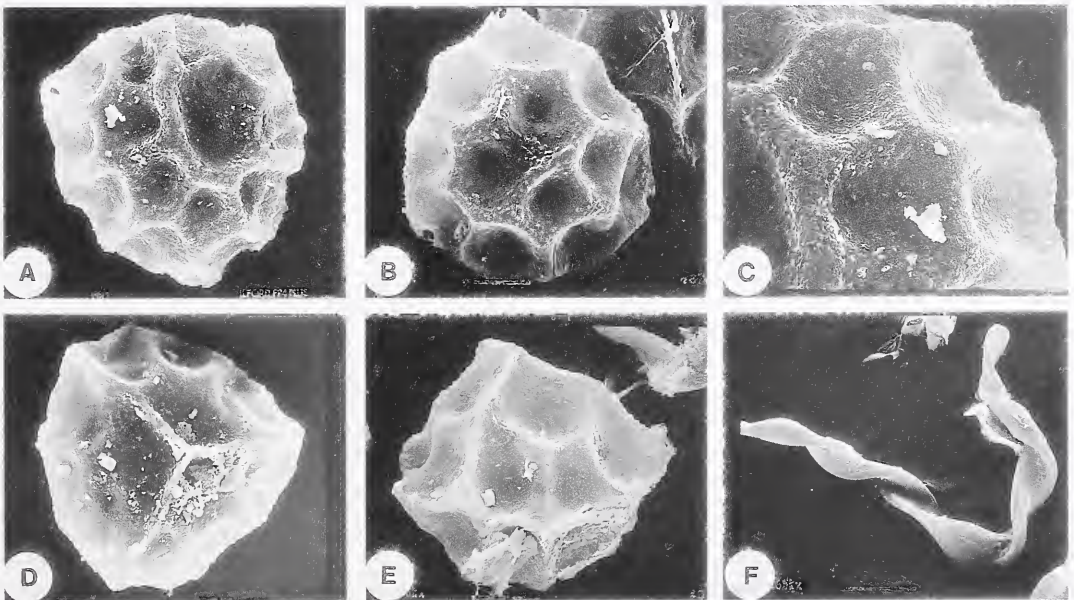


FIGURE 10.—*Plagiochasma eximium*. SEM micrographs of spores and elater. A, B, distal face; C, much enlarged view of margin, some areolae and walls on distal face; D, proximal face; E, side view of proximal face; F, elater. A, C, D, T.R. *Sim CH 1163*; B, E, F, T.R. *Sim CH 1186*. A, $\times 470$; B, $\times 482$; C, $\times 925$; D, $\times 459$; E, $\times 501$; F, $\times 308$.

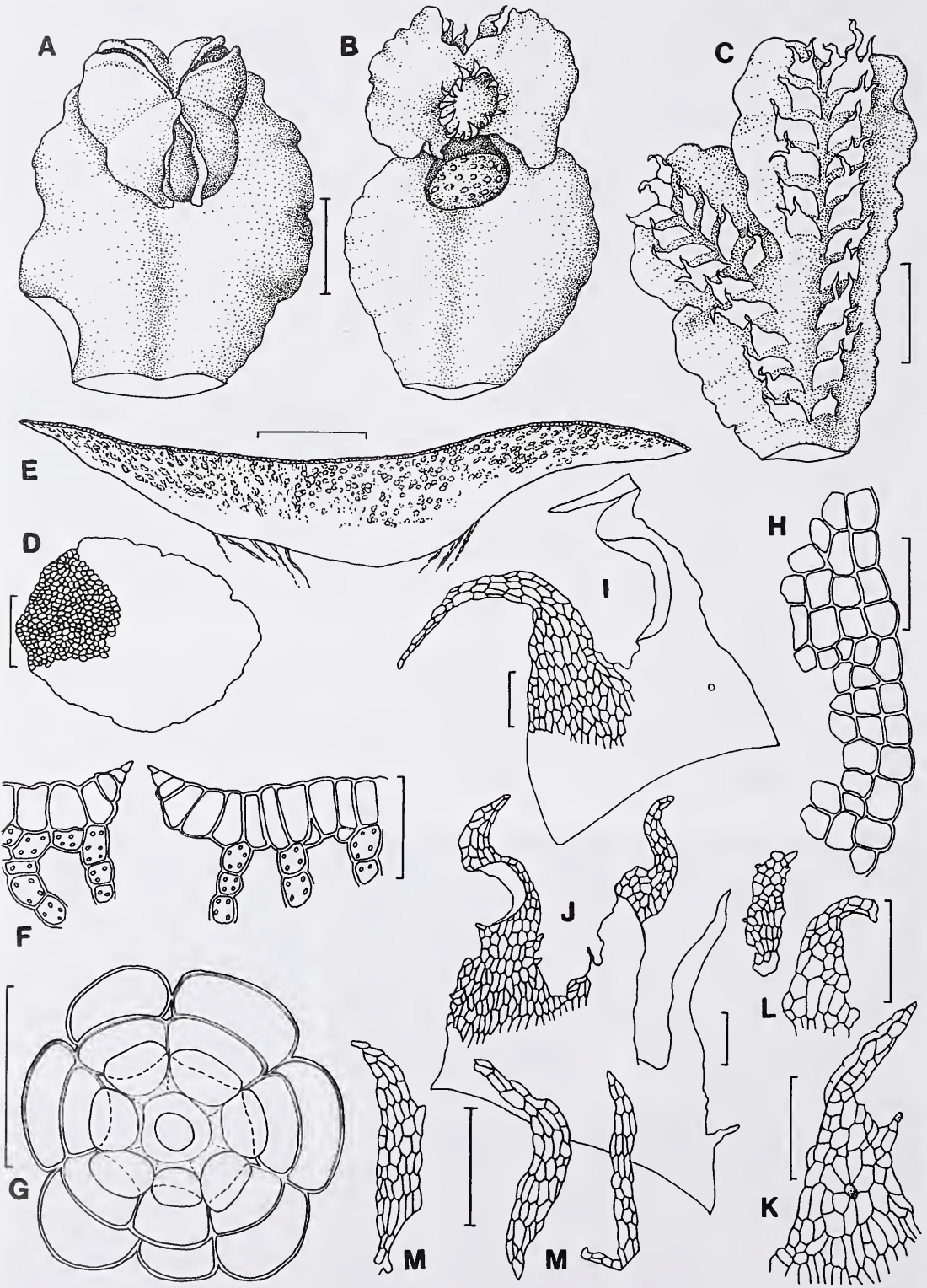


FIGURE 11.—*Plagiochasma beccarianum*. A, thallus with mature carpocephalum; B, thallus with archegoniophore and androecium; C, ventral face of thallus; D, transverse section of stalk; E, transverse section of thallus; F, transverse section of air pore, dorsal cells and air chambers; G, air pore and surrounding cells from above; H, margin of thallus; I, scale with 2 appendages; J, scale with 3 appendages; K, scale appendage; L, male palcae; M, female palcae. A, B, D–K, M, *Volk 00950*; C, *S.M. Perold 2992*; L, *S.M. Perold 2995*. Scale bars: A–C, 2 mm; D, 100 μ m; E, 1 mm; F–H, 50 μ m; I–M, 250 μ m.

Drakensberg by H. Anderson, E. Esterhuysen, S.M. Perold and O.H. Volk (Figure 6). Arnell (1963) gave no description or illustration of *P. eximium*, merely listing it in his key to the species of *Plagiochasma*. This species is widespread in Africa and has been reported by Bischler (1978) from Sierra Leone, Guinea, Cameroons, Zaïre, Djibouti, Ethiopia, Uganda, Kenya, Tanzania, Malawi and the following islands: Cape Verde, Réunion and Madagascar (Bischler 1990). Its distribution extends to the Arabian Peninsula: Saudi Arabia, Yemen, Oman and to Socotra. Frey & Kürschner (1988) consider *P. eximium* to be a palaeotropical taxon with tropical African distribution.

Many of the collections are from high altitudes, such as the Drakensberg in southern Africa, where the plants grow in shady kloofs on muddy rock faces or on soil covering rocks or under boulders. As far as could be ascertained, the specimen, *Sim CH 1186*, from Victoria Falls seems to be the first record of this species from Zimbabwe.

Plagiochasma eximium can be distinguished by its robust, yellow-green thalli with large, deep pink to wine-red ventral scales narrowed above into (1)2 or 3 tapering appendages which are only a little constricted or pleated at the base. Ventrally the flanks are wrinkled and deep red, not dark purple. Elaters from the few spore-bearing plants studied are bispiral, but Bischler (1978) also found them to be 3- or 4-spiral and generally distinct along only a small part of their length.

Bischler (1978) states that herbarium specimens of *P. eximium* can look quite different from each other. Those from damp, shady places (e.g. a cave) have thin, olive-green thalli and decolorate margins, large epidermal cells with thin walls, and smaller, pale scales. Others have thicker, yellowish green thalli with pigmented margins, slightly smaller epidermal cells with well-developed trigones and large, dark red scales. Bischler (1978) considers them to be ecological variants of the same species. Other characters that are quite variable are the width of the thalli, the thickness of the radial walls at the air pores, the presence or absence of teeth at the base of the scale appendages, the spore ornamentation and the presence or absence of spiral thickenings in the elaters.

5. *Plagiochasma beccarianum* Steph. in Bulletin de l'Herbier Boissier, Sér. 1, Vol. 6.10: 781 (1898); Bischl.: 257 (1978); Volk: 240 (1979). Type: Abyssinia (Bogoss), Keren, in Monte Deban, inter 4500' & 5500', 1870, *Beccari* (Fl. holo.; 009583G, iso!).

Thallus medium-sized to rather large, flat to very slightly concave medianly and gently arching downward toward margins, ligulate to lingulate or broadly ovate (Figure 11A, B), bright green, shiny, along narrow edge of margins purple; finely and irregularly areolate, pores distinctly visible, raised, when wet; thallus margins frequently tightly inflexed or sometimes incurved, exposing shiny, ink-black or very dark purple, transversely striate underside of wings, partly covered by purple scales, when dry; in crowded, gregarious patches, once or twice pseudodichotomously furcate, sometimes with apical innovations and then articulated. *Branches* 8.0–20.0 × 3.5–5.0 (–6.0) mm, 600–850 µm thick over midrib, laterally thinning out

into attenuate wings (Figure 11E); apex notched, with several purple ovate-lanceolate scale appendages recurved over edge; margins acute, thin, sparingly scalloped and slightly undulate; flanks sloping obliquely, black or purple, ventral face medianly keeled and green, partly obscured by 2 rows of purple scales, one on either side (Figure 11C).

Dorsal epidermal cells unistratose, hyaline, rectangular to polygonal, 25.0–37.5 × 20.0–27.5 µm, walls thin, except at corners where thickened and rounded with trigones, in transverse section 30–35 µm thick, smooth externally, along margins (Figure 11H) 2 or 3 rows of short rectangular cells, ± 25.0 × 22.5 µm; air pores not so numerous, distances between them quite variable, 137–287 µm, slightly raised (Figure 11F), simple, round or oval, 15.0–30.0 × 17.5–25.0 µm, surrounded by an innermost hyaline ring, 5 µm wide, of collapsed cells, and then by 2 (or partly by 3) concentric rings of 6–8 cells in each, inner cells ± rounded or transversely oval, 10.0–15.0 × 15.0–27.5 µm, partly overlying next row of bluntly triangular cells, 12.5–17.5 × 25.0–35.0 µm, outermost row of cells (if present), 20–25 × 35 µm, radial walls not thickened (Figure 11G). *Assimilation tissue* 300–400 µm thick, ± ½ thickness of thallus, air chambers in several layers, 30.0–57.5 µm wide, cells in bounding walls 22.5–32.5 × 22.5–27.5 µm, occasionally with dark brown oil body almost filling cell, 37.5 × 35.0 µm; storage tissue occupying ventral part of thallus, cells transversely oval to rounded or angular, 30.0–37.5 µm wide, walls mostly faintly reddish and thickened at corners, intercellular spaces here and there, some cells containing an oil body; rhizoids either smooth, 12.5–25.0 µm wide, or pegged, 10.0–12.5 µm wide. *Scales* and appendages deep purple to violet, in 2 forwardly directed ventral rows, one on either side of midrib, ± asymmetric, with flatly arched base, gradually tapered above into 2 (Figure 11I) or 3 (Figure 11J) lanceolate appendages up to 1000 µm long, not constricted at base (Figure 11K), ± 400 µm wide, cells mostly rectangular to 6-sided, 62.5–100.0 × 27.5–30.0 µm, at apex often a single conical cell, 22.5 × 20.0 µm, at margins lower down a few prominent teeth, ± 50 × 20 µm, sometimes basally supported on 1 or 2(3) cells in series; body of scale ± 850 µm long, 1750 µm across base, cells 4- or 6-sided, 50–75 × 25–30 µm, at margin narrower, ± 17.5 µm wide and thinner-walled, also present a few (± 10) scattered smaller cells, which had contained an oil body.

Monoicous, but receptacles often on separate plants. *Androecia* in single sessile cushions, kidney-shaped or rounded, up to 2 mm wide, medianly and generally just proximal to apical innovation (Figure 11B), basally surrounded by purple paleae, 300–400 × 160–200 µm, apically pointed or blunt (Figure 11L), cells 32.5–37.5 × 15.0–20.0 µm, occasionally containing an oil body and some marginal ones with a papilla. *Archegoniophores* generally single, medianly near apex of main branch (Figure 11A) or on apical innovation, sometimes 2 in acropetal sequence, basally surrounded by dark paleae with pointed apex (Figure 11M), up to 500 × 80 µm, cells rectangular, ± 45.0 × 22.5 µm, sometimes a few papillae at marginal cells. *Carpoocephala* up to 3.5 × 3.5 mm, when 4 lobes present (Figure 11A), raised on stalk, 1.2–3.5 mm long, in transverse section (Figure 11D), 825 × 675 µm, cortical

cells in 1 row, thick-walled externally, $15\text{--}20 \times 15\text{--}20 \mu\text{m}$; medullary cells thin-walled, rounded or polygonal and then angled, up to $37.5 \times 25.0 \mu\text{m}$. *Spores* $80\text{--}90 \mu\text{m}$ in diameter, triangular-globular, polar, light brown, translucent, wing $10 \mu\text{m}$ wide, porate at corners, margin finely crenulate; ornamentation similar on both faces: distal face (Figure 12A–C) with 3 or 4 areolae across, $20\text{--}25 \mu\text{m}$ wide, walls $\pm 7.5 \mu\text{m}$ wide and finely granular; proximal face (Figure 12D, E) with distinct triradiate mark, ridge $\pm 7.5 \mu\text{m}$ high, each of 3 facets with 4 areolae, walls wide and sprinkled with granules. *Elaters* (Figure 12F) light brown, $195\text{--}258 \mu\text{m}$ long, $12.5 \mu\text{m}$ wide in middle, tapering toward ends, $7.5 \mu\text{m}$ wide, occasionally branched, bispiral except at tips. *Chromosome number*: $n = 9$ (Bischler 1978).

Plagiochasma beccarianum is regarded as quite a heterogeneous species, but so closely resembling *P. eximium* that the two species are often difficult to distinguish when sterile (Bischler 1978). In the few southern African specimens of *P. beccarianum* available for study, it appears that the fresh thalli are a clear green dorsally, not yellow-green, and the underside of the wings as well as the scales are deep purple and not dark red as in *P. eximium*. The two or three scale appendages of *P. beccarianum* are \pm acuminate or narrowly triangular and not constricted at the base; their margins are irregularly toothed.

This species is rare and has been reported from relatively few places in Africa; except for Namibia (Volk 00950), it is mostly found along the eastern part of the continent, namely Ethiopia, Tanzania and Zambia (Bischler 1978). It has also been reported from the Arabian Peninsula (Frey & Kürschner 1988) and from Socotra (Bischler 1978; Frey & Kürschner 1988). Some

specimens from the Northern and Eastern Transvaal have recently been collected (Figure 6), where they grew in a shady kloof under boulders or in a rocky crevice in Blyde River Canyon respectively. Frey & Kürschner (1988) regard it as a palaeotropical taxon with a tropical African distribution.

Bischler (1978) states that *P. beccarianum* belongs to a complex represented by several species in Asia and America. She thinks that this group probably diversified more rapidly on these two continents than in Africa and that the heterogeneity of *P. beccarianum* could be due to a slower African evolution of the complex which has not as yet achieved the separation of distinct taxonomic units.

SPECIMENS EXAMINED

(held at PRE, unless otherwise indicated)

H. Anderson 1230, 1245, 1254 (1a); CH 13477, CH 13512 (1b); CH 13588 (1a), CH 4498–CH 4500 (4). T. Anderson 13 (1a).

Badenhorst CH 4360 (1a). Bean & Oliver 2354 (1a). Bester 15 (1a). Bews CH 1132, CH 1152, CH 1232 (1a). Borle CH 1340 (2). Botha 136=145, CH 1170, CH 13240 (1a). Bottomley CH 155, CH 160, CH 173 (1b); CH 175 (3); CH 198 (1a); CH 268 (2), CH 269 pp. (1b); CH 269, CH 3661 (1a). Brueckner 225 (3) BOL. Brusse 4123, 4124, 4126–4130, 4261 (1a). Burrows 2363, 2520 (1a). Burt Davy 15176 (3).

Condy 45 (1a); 47 (3); 82, 83 (1b); 84 (3); CH 13629, CH 13631 (1a). Cooper 962 (1a).

Dieterlen 793C (1a). Doidge CH 169, CH 3601 (1a). Du Preez 2107, 2108 (1a).

Edwards CH 1153 (1a). Esterhuysen 26166A (1a); 26166 (4) BOL. Eyles 937, 1181 (1a).

Germishuizen 5393, 5385 (1a). Giess, Volk & Bleissner 6768 (1a, 1b, 3). Giffen 2 (CH 1228) (1a). Glen 1250 (5); 1644 (1b); 1722, 2241, 2846, 3171 (1a), Götze 16 (1a). Graham CH 1174 (1a).

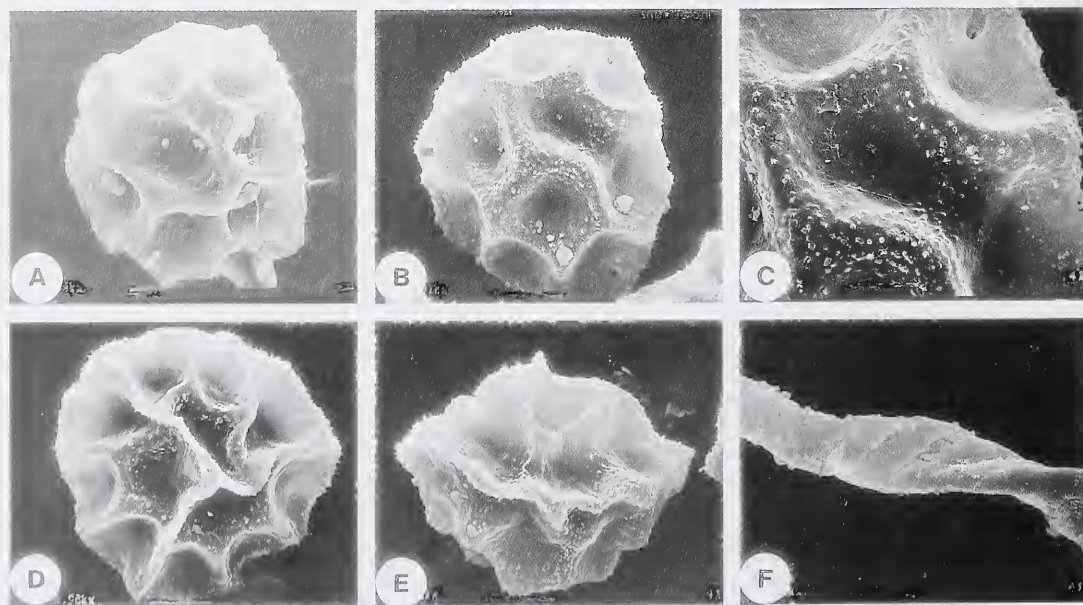


FIGURE 12.—*Plagiochasma beccarianum*. SEM micrographs of spores and elater. A, B, distal face; C, much enlarged view of margin, pore, some areolae and walls; D, proximal face; E, side view; F, part of elater much enlarged. A, Glen 1250; B–F, Volk 00950. A, $\times 437$; B, E, $\times 472$; C, $\times 936$; D, $\times 460$; F, $\times 1014$.

Hansen 3241 (1a). Hedberg 2150 BOL (4). Heilgendorff CH 13611 (1a). Hepburn 3 (= CH 1155) (1a). Herman 338 (1a). Heymann, Cloete & Burgoyne 67 (1b); 68 (3). Hilton 54706 (1a) BOL.

Jacot Guillarmod CH 3675, CH 3791, CH 4187 (1a). Jacot Guillarmod, Gelliffe & Mzamanie 114, 287 (1a). Jensen 442 (1a).

Koekemoer 104, 296 (1a); 637 (1b); 842, 912, 1024a (1a). Kreiner (= Volk 89-31) (1b).

Leighton 3284 (1a) BOL. Liebenberg 7593 (1a). Lyle 7085 (1a).

Magill 6372, 6398, 6413, 6418, 6431, 6480 (1a). Manning CH 13590 (1a). Mogg 144 (1a); CH 3720, 37590 (1b). Moore CH 55 (1a). Morley 358 (1a). Moss CH 1256 (1a). Mott 860 (1a).

Oliver 1449 BOL, 1464, 10133 (1a). Örtendahl 696A (1a).

Pearson 9849 (1a). S.M. Perold 55 (1a); 176–178 (1b); 224 (3); 225 (1b, 3); 229 (3); 260, 301, 852 (1a); 854 (2); 947, 948, 1292, 1297, 1477, 1504, 1514, 1876, 2167, 2168 (1a); 2498 (4); 2508 (1a); 2586 (1b); 2799, 2803 (1a); 2974 (1b); 2976 (3); 2984 (1a); 2985 (1b); 2992, 2995 (5); 2997, 2998 (1b); 3002, 3058, 3062 (1a). Perold & Koekemoer 2944, 2949, 2950, 2972 (1a); 3135 (2). Perold, Koekemoer & Smook 3020 (1a). Pieterse 100 (1a). Playford CH 1264 (1a). Pole Evans CH 11, CH 14 (1b); CH 457, CH 1154 (1a). Potts CH 1168, CH 1173, CH 1230, CH 1258 (1a).

Retief 1543, 1675a (1a). Retief & Gernishuizen 170, 408 (1a). Retief & Shearing 1228 (1a).

Saaiman 309 (1a). Schelpe s.n. (BOL 54717), 2019 (1a); 4781 (1b); 4782, 4852 BOL, 5283, 5290 BOL (1a); 5587 BOL (1b); 5823, 5834, 6360 (1a). Scott 21 (1a). G.W. Sim 8109 (1a). T.R. Sim CH 1157 (1a); CH 1163 (4); CH 1166, CH 1180–CH 1185 (1a); CH 1186 (4); CH 1189, CH 1199 (1a); CH 1200 (4); CH 1201, CH 1209, CH 1225 (1a). Smook 4425, 4486, 5176a, 7929, 7952, 8240a, 8639, 8745 (1a).

Tidmarsh CH 3175 (1a, 1b).

University of Durban-Westville 2152 (1a).

Vahrmeijer CH 13145 (1a). Van der Bijl 498 (1a). Van der Westhuizen & Deetlefs 1 (1a) BOL. Van Rooy 690, 734, 779, 791, 1166, 1347, 1467, 2025, 2366, 2379, 2408, 2423, 2525, 2595, 2621, 2657, 2679, 2726, 2771, 2777, 2782, 3160, 3197, 3212, 3293, 3542 (1a). C.M. Van Wyk 2679, 3190 (1a). Venter 8612 (1a). Viljoen CH 4524 (1a). Vlok 2662 (1a). Volk 212, 00482, 00554, 00639, 00684, 00909 (1a); 00948 (1b); 00950 BOL (5); 01000, 01348 (1a); 5020, 6105, 6657, 6854 (1b); 6900, 11361, 11363, 11406, 12728, 81/063, 81/093 (1a); 81/183 (3); 81/194, 81/274, 81/287 (1a); 84/630, 84/650 (1a, 4); 84/724 (1a). Vorster 655 (1a).

V. Wager 100 (1a). Wehnan CH 1141 (1a).

Young CH 1164 (1a).

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FSA contributions 2: Asphodelaceae/Aloaceae, 1029010 *Chortolirion*

G.F. SMITH*

Chortolirion A. Berger in Das Pflanzenreich 4, 38, III, II (Heft 33): 72 (1908); E. Phillips: 149 (1926), 187 (1951); Oberm.: 119 (1973). Type: *Haworthia angolensis* Baker, i.e. *Chortolirion angolense* (Baker) A. Berger.

Herbaceous perennial; acaulescent, with leaves originating from a short, simple (rarely once branched), cylindrical, subterranean butt ± 9 mm in diameter; roots few, fusiform, fleshy, up to 8 mm in diameter; bulb with few, loosely packed, membranous scales covering the inner, slightly fleshy leaf bases, ovoid-oblong, 30–40 mm long, ± 20 mm in diameter. *Leaves* rosulate, slender, grass-like, flaccid, erect, deciduous, ± 10 , light green to glaucous green, usually once or twice twisted, upper 5–10 mm of leaves often dry, ± 150 mm long, diameter ± 2 mm; *upper surface* canaliculate, immaculate or with very few white spots near base; *lower surface* convex, copiously white-spotted near base, the spots often slightly tuberculate-subspinulose; *margins* armed with soft, white, decurved teeth, ± 0.5 mm long, larger low down, smaller upwards, 1–2 mm distant throughout. *Inflorescence* ± 360 mm tall; *peduncle* simple, diameter ± 2 mm, ± 200 mm long; *sterile bracts* membranous, ovate, abruptly long acuminate, erect, clasping the peduncle, keeled with 1–3 reddish brown vein(s), ± 8 mm long; *raceme* ± 150 mm long, ± 14 spirally arranged flowers and buds, 3 open simultaneously; *floral bracts* membranous, mucronate, keeled, clasping the pedicels, longer than the pedicels, 5 mm long; *pedicels* erect, persistent, brownish green, 1–2 mm long, diameter 1 mm. *Flowers* erect, zygomorphic, greenish, brownish or pinkish white with greenish keels to the segments, base obtuse; perianth funnel-shaped, tube straight, constricted to 3 mm above, 14 mm long, ± 2 mm across; *segments* greenish white with darker green veins, not free to the base, closely adhering for two thirds of the length, limb bilabiate; upper-outer segments strongly recurved, retuse, spoon-shaped at tips; upper-inner segment slightly recurved, obtuse, spoon-shaped at tip, lower-outer segments recurved, lower-inner segment strongly recurved, tips flared; bud narrow, straight, decurved and pinkish at tip; *stamens* 6, of \pm equal length, inserted within the perianth tube, attached below ovary, ± 7 mm long; *filaments* white, thinner towards apex; *anthers* yellow, dorsifixed, dehiscing longitudinally and introrsely; *ovary* green, sessile, 3 mm long, diameter 2 mm; *style* white, straight, capitate, 4 mm long. *Fruit* light green, capsule trilobular, cylindric, apically acute, dehiscing loculicidally, chartaceous when dry, ± 15 mm long, 5–6 mm in diameter. *Seed* dark brown to black, angled, shortly winged, ± 3 mm long. *Chromosome number*. $2n = 14$. Figure 1.

Monotypic. In southern Africa it occurs in Namibia, Botswana, Lesotho and in all the provinces of the Republic of South Africa except the Western Cape. For KwaZulu-Natal the genus is known from a single accession only [grid reference unknown: Zululand, *Anon. s.n.* (K)!] which is not shown in Figure 2. It also occurs in Angola and Zimbabwe. *Chortolirion* is found from near sea level up to altitudes of more than 2 000 m; the general habitat of *Chortolirion* is the climatically severe inland area above the Great Escarpment. The genus is adapted to sparse or dense grasslands in which a wide variety of graminoids and forbs dominate. These grasslands are usually subject to natural or deliberate seasonal burning.

Chortolirion is morphologically quite distinct from *Haworthia*, especially with regard to the presence of an underground bulbous rootstock. Furthermore, it is the only haworthioid taxon of which the leaves are deciduous and die back to ground level after fires or frost.

The name *Chortolirion* means 'heath lily' and refers to the fact that plants of the genus usually occur in grassland and, especially when not in flower, can easily be mistaken for small tufts of grass.

Chortolirion angolense (Baker) A. Berger in Das Pflanzenreich 4, 38, III, II (Heft 33): 73 (1908). Type: Angola, Huilla, regio subtemperata, in dumetis arenosis, *Welwitsch 3756* (BM, holo., PRE, photo.).

Description as for the genus.

Haworthia angolensis Baker: 263 (1878); Baker: 210 (1880); Baker: 469 (1898); Oberm.: 119 (1973). Type: as above.

H. tenuifolia Engl.: 2 (1888); Baker: 355 (1896). *Chortolirion tenuifolium* (Engl.) A. Berger: 73 (1908). Type: Betschuanaland, Manjereng pt. Kuruman, in arenosis alt. 1 200 m, *Marloth 1049* (B, holo.).

H. stenophylla Baker: sub t. 1974 (1891); Baker: 355 (1896). *Chortolirion stenophyllum* (Baker) A. Berger: 72 (1908); Dyer: t. 932 (1944). Type: Transvaal, grassy mountain slopes of the Saddleback range near Barberton, *Galpin 858* (K, holo.).

H. saundersiae Baker: sub t. 1974 (1891), nom. nud.

H. subspicata Baker: 998 (1904). *Chortolirion subspicatum* (Baker) A. Berger: 74 (1908). Type: Transvaalkolonie, Modderfontein, *Conrath 645* (Z, holo.).

Chortolirion bergerianum Dinter: 24 (1914). Type: Deutsch-Südwest-Afrika (Namibia), the Farm Voigtland, 20 km to the east of Windhoek, K. Dinter, Neue und wenig bekannte Pflanzen Deutsch-Südwest-Afrikas t. 12 (1914) (holo., icono.).

Icones: Dyer: t. 932 (1944); Fabian & Germishuizen: t. 13a (1982).

Vouchers: Dinter 4295 (B); Hanekom 1843 (PRE); Smith 8 (PRU); Smith 12 (PUC); Ubbink 318 (PUC).

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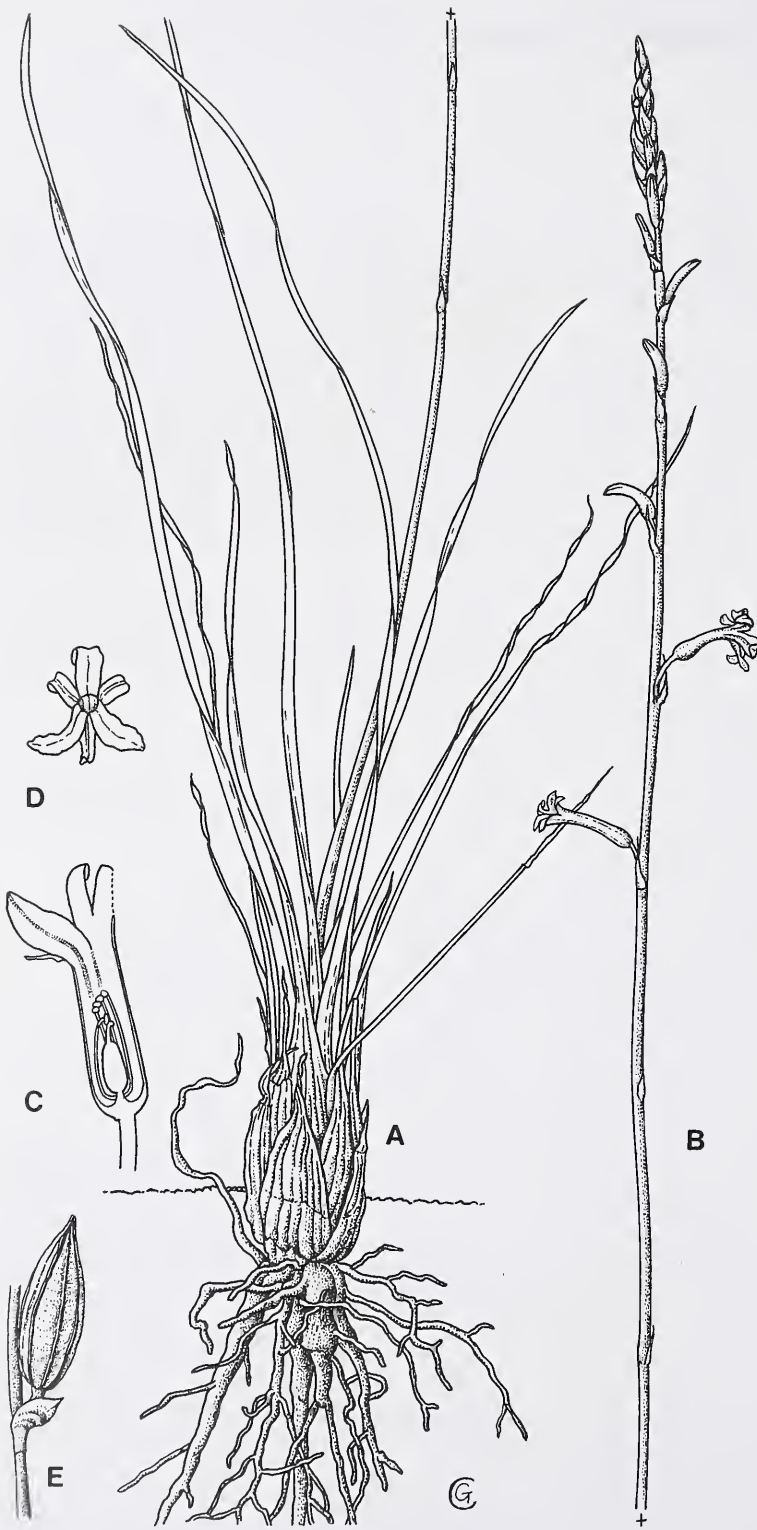


FIGURE 1.—*Chortolirion angolense*: A, habit, $\times 1$; B, inflorescence, $\times 1$; C, longitudinal section of flower (one stamen removed), $\times 3$; D, flower face showing reflexed segments, $\times 2$; E, fruit, acuminate capsule, $\times 1.5$. All drawings, except E, were made from live material collected by Craib, deposited under *Smith 234* (PRE). Fruit drawn from *Leeman s.n.* (PRE 34956). Artist: Gillian Condy.

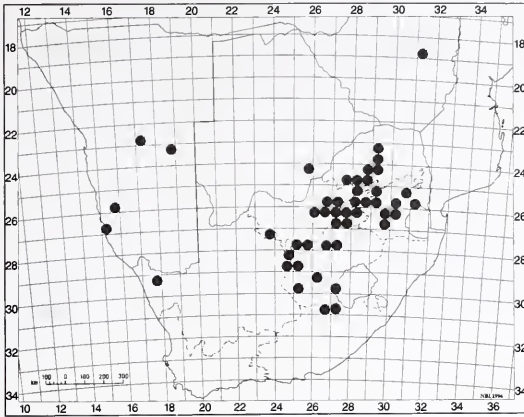


FIGURE 2.—Distribution of *Chortolirion angolense* in southern Africa.

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FSA contributions 3: Asphodelaceae/Aloaceae, 1028010 *Poellnitzia*

G.F. SMITH*

Poellnitzia *Uitewaal* in *Succulenta* 22: 61 (1940); D. R. Hunt: sub t. 804 (1981); G. F. Sm.: 75 (1994b); G. F. Sm. & B-E. van Wyk: t. 2119 (1995). Type: *Apicra rubriflora* L. Bolus, i.e. *Poellnitzia rubriflora* (L. Bolus) *Uitewaal*.

Herbaceous perennial; caulescent, offsetting at and near the base, stems erect when young, ascending when old, up to 250 mm long, ± 10 mm in diameter; roots terete, 2–3 mm in diameter. *Leaves* thick, hard, usually four-ranked in spirally arranged rows, squarrose-imbricate, ovate-squamiform, apex triquetrous, pungent-acuminate, dark green to glaucous green, coated with a waxy layer, 20–40 mm long, ± 20 mm broad near base, up to 5 mm thick; *upper surface* concave or flat, immaculate or with very few lighter green spots near base; *lower surface* convex, keeled towards tip, usually with few lighter green spots, spots sometimes confluent to form longitudinal lines; *margins* and keel apex minutely scabrid. *Inflorescence* up to 500 mm long; *peduncle* simple, erect, slender, ± 300 mm long, ± 3 mm in diameter; *sterile bracts* membranous, lanceolate-acuminate, keeled with one reddish brown vein, ± 7 mm long; *raceme* borne horizontally, ± 200 mm long, ± 28 spirally arranged flowers and buds, 3–8 accessible to pollinators simultaneously; *floral bracts* membranous, lanceolate, keeled, clasping pedicels, shorter than pedicels, 3–5 mm long; *pedicels* erect, persistent, brown, 6–8 mm long, ± 1 mm in diameter. *Flowers* borne secundly erect, narrowly tubular, elongate, slightly constricted above ovary and below segment lobes, upper one-third slightly decurved, tube red to orange, upper one-tenth of perigone members dark green, connivent, reduplicate-valvate, tips of segments scarcely separated, ± 20 mm long; 3 mm in diameter; *segments* red to orange with brownish midveins, not free to base, fused, closely adhering where free, apically spoon-shaped, outer segments slightly larger than inner, margins apically minutely crenulate-erose, yellow; *stamens* 6, subequal, inserted within perianth tube, attached below ovary, ± 18 mm long; *filaments* light green; *anthers* yellow, dorsifixed, dehiscing longitudinally; *ovary* green, sessile, 6–7 mm long, 3 mm in diameter; *style* white, straight, capitate, \pm equalling anthers, ± 12 mm long. *Fruit* green, capsule trilobular, cylindrical, apically retuse, dehiscing loculicidally, chartaceous when dry, ± 16 mm long, 3–4 mm in diameter. *Seed* dark brown to black, angled, shortly winged, ± 4 mm long. *Chromosome number*: $2n = 14$. Figure 1.

Monotypic. *Poellnitzia* is endemic to the Robertson Karoo (districts of Robertson, Bonnievale and McGregor) which is one of the drier, predominantly winter rainfall areas bordering the Fynbos Biome. The vegetation in the

habitat of *Poellnitzia* can be broadly classified as Karroid Shrublands and the entire range of distribution of the genus falls within the Succulent Karoo Biome. *Poellnitzia* is found ± 150 –250 m above sea level. Figure 2.

On vegetative morphological grounds *Poellnitzia* shows affinities with some representatives of *Aloe*, *Astroloba* and *Haworthia*. However, the flower morphology of *Poellnitzia* is unique in the family Aloaceae in that the dark green, free portion of the segment lobes is connivent and reduplicate-valvate with the very tips of the segments scarcely separated.

The genus name *Poellnitzia* honours Dr Joseph Karl Leopoldt Arndt von Poellnitz (4 May 1896–15 February 1945). He was a German agriculturist and botanist with

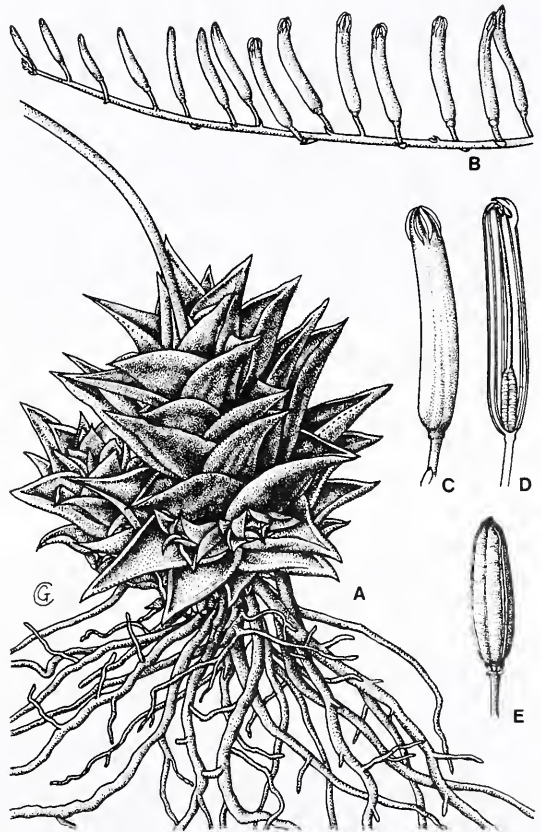


FIGURE 1.—*Poellnitzia rubriflora*: A, habit, $\times 0.7$; B, terminal portion of raceme, $\times 0.7$; C, lateral view of flower, $\times 1.4$; D, longitudinal section of flower (three stamens removed), $\times 1.4$; E, fruit, trilobular capsule, $\times 1$. All drawings, except E, were made from live material of Smith 184 (PUC). Fruit drawn from C.J. Burgers 78 (PRE). Artist: Gillian Condy.

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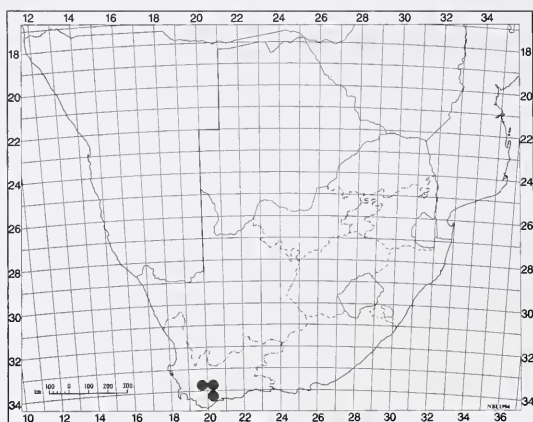


FIGURE 2.—Distribution of *Poellnitzia rubriflora*.

a general interest in succulent plants, particularly the family Aloaceae. Both von Poellnitz and his only daughter died tragically in bombing raids during World War II.

***Poellnitzia rubriflora* (L. Bolus) Uitewaal** in *Succulenta* 22: 61 (1940); D. R. Hunt: sub t. 804 (1981); G. F. Sm.: 75 (1994b); G. F. Sm. & B-E. van Wyk: t. 2119 (1995). Type: Western Cape: southwestern region; Swellendam Div., Bonnie Vale, *Smith s.n.* (*National Botanic Gardens, No. 2/17*) (*Herbarium Bolusianum 45213*) (BOL., holo!).

Apicra rubriflora L. Bolus: 13 (1920); Uitewaal: 28 (1939). *Astroloba rubriflora* (L. Bolus) E. Lamb: 230 (1955) nom. illegit. *Haworthia rubriflora* (L. Bolus) Parr: 196 (1971). *Aloe rubriflora* (L. Bolus) G. D. Rowley: 2 (1981).

Apicra jacobseniana Poelln.: 95 (1939). *Poellnitzia rubriflora* var. *jacobseniana* (Poelln.) Uitewaal in Jacobsen & Rowley: 80 (1955). *Haworthia rubriflora* var. *jacobseniana* (Poelln.) Parr: 89 (1972)

comb. inval. Type: 'Kapland: Worcester, leg. Mrs Florence Morris; Typ (= *Triebner 34*) im Botanischen Garten Kiel kultiviert,' no specimen preserved [unnumbered photograph in *Kakteenkunde* (1939): 95 lecto.!, icono.].

Icons: Hunt: t. 804 (1981); Court: 140 (1981); Smith: 17 (1994a).

Vouchers: *Acocks 14098* (PRE); *Burgers 78* (PRE); *Smith 9* (PRU); *Smith 174, 177* (PUC).

Description as for the genus.

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Notes on the typification of some species of *Aloe* (Asphodelaceae/Aloaceae)

H.F. GLEN* and G.F. SMITH*

ABSTRACT

Lecto- or neotypes are designated for *Aloe thompsoniae* Groenew., *A. micracantha* Haw., *A. schmidtiana* Regel (a synonym of *A. cooperi* Baker), *A. longistyla* Baker, *A. aristata* Haw., *A. longiaristata* Schult. & Schult. f., (a synonym of the preceding name), *A. humilis* (L.) Mill. var. *incurva* Haw., *A. glauca* Mill., *A. muricata* Schult. (a synonym of the preceding name), *A. saponaria* (Aiton) Haw. var. *latifolia* Haw. (a new synonym of *A. maculata* All.) and *A. pluridens* Haw. The confusing citation of the type of *A. thornicroftii* Pole Evans is clarified.

UITTREKSEL

Lekto- of neotipes word aangewys vir *Aloe thompsoniae* Groenew., *A. micracantha* Haw., *A. schmidtiana* Regel ('n sinoniem van *A. cooperi* Baker), *A. longistyla* Baker, *A. aristata* Haw., *A. longiaristata* Schult. & Schult. f. ('n sinoniem van die voorafgaande naam), *A. humilis* (L.) Mill. var. *incurva* Haw., *A. glauca* Mill., *A. muricata* Schult. ('n sinoniem van die voorafgaande naam), *A. saponaria* (Aiton) Haw. var. *latifolia* Haw. ('n nuwe sinoniem van *A. maculata* All.) en *A. pluridens* Haw. Die verwarrende stering van die tipe-eksemplaar van *A. thornicroftii* Pole Evans word opgeklaar.

INTRODUCTION

In the course of studies directed towards both a revision of the southern African species of *Aloe* and the data capture for PRECIS-FLORA, it was found that the typification of several well known names was ambiguous. Details necessary to remove the ambiguity in three cases were recently published in some detail by Smith (1990a, b) and Glen & Hardy (1991), but these are only three of the more involved cases. In a significant number of instances, all that is required is the choice of a lectotype or neotype—which hardly merits a separate paper, or even a separate short note, for each name. The purpose of this paper, then, is to gather up all these problems into a single worthwhile publication.

Typification of extant yet untypified names is not obligatory (Art. 9.9 of the *International Code of Botanical Nomenclature*, but see Art. 10.2). In a taxonomically difficult genus such as *Aloe*, however, typification is often necessary to establish the application of the plethora of available names. Furthermore, it fixes the concepts of the present authors regarding selected names in *Aloe* that should be reduced to synonymy.

The names in question are considered in a taxonomic order approximating that used by Berger (1908) and Reynolds (1950). They are dealt with in groups roughly following those employed by these authors. In all cases, lectotypes and neotypes have been chosen bearing in mind two criteria. In order of importance, these are: 1, preservation of current usage, as far as possible establishing the intent of the original author, and 2, accessibility of material.

NOTES ON TYPIFICATION

***Aloe thompsoniae* Groenew.** in Tydskrif vir Wetenskap en Kuns 14: 64 (1936) sphalm. *thompsoni*. Lectotype: Transvaal, Haenertsburg, *Thompson s.n.* in PRE 274 (PRE. lecto!., here designated).

Although not cited by Groenewald (1936), who did not designate a type, the specimen designated here (Figure 1) is the only one in PRE that was collected by the person commemorated in the name, Dr (Mrs) Sheila Clifford Thompson of Haenertsburg, Pietersburg District (Reynolds 1946; Prinsloo 1972) and is therefore relevant type material. In this context it is also noteworthy that Dr F. Z. van der Merwe, an avid collector of aloes in the mid-1900's, passed most of his newly described species of *Aloe* on to Mr B. H. Groenewald who described them and deposited the specimens in PRE (Gunn & Codd 1981). In general it is therefore not worth searching other herbaria for material suitable as lectotypes of the names of species described by Groenewald.

***Aloe micracantha* Haw. (*microcantha* auctt.)** in Supplementum plantarum succulentarum: 105 (1819). Neotype: *Burchell 4482* (K!, here designated).

Haworth (1819) cites no type for this species, but states that he saw a small plant collected in the wild and planted in the Royal Botanic Gardens, Kew. Sims (1821) states 'For this very rare species, which is supposed not to exist in any of our other collections except in that of Kew, where it was introduced about two years since from the Cape of Good Hope, we are indebted to Thomas Kitchin, Esq., of Norwich, in whose garden, rich in succulent plants, it flowered in July last.' Therefore one is ultimately forced to rely on Sims's skill and good faith in having compared the Kew and Norwich plants (neither of which is accessible any more). This problem of speculative typification based on circumstantial evidence can fortunately be circumvented due to the existence in Kew of

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FIGURE 1.—Thompson s.n. (PRE 274), the lectotype specimen of *Aloe thompsoniae*.

two Burchell specimens of *A. micracantha* (Figure 2). They are both mounted on a single sheet, and are clearly identifiable with locality material nowadays referred to *A. micracantha* (Smith 1993). Selection of one of these specimens gives the name an accessible, readily identifiable type that stabilizes current usage. In addition, this specimen is the element that comes closest historically to being a live plant with which Haworth was familiar. Selection of either the *Botanical Magazine* plate of the species (Sims 1821), or an excellent colour plate kept at Kew of *A. micracantha* (Figure 3) as neotype for the name was considered, because, especially in the case of succulent plants, a drawing is often more diagnostic than a specimen and therefore more useful for fixing the application of a name (Smith 1990a). The Kew plate has often been attributed to Franz Bauer, but is by an unknown artist (G. Ll. Lucas pers. comm.). In the case of *A. micracantha*, the Burchell specimens are of such exceptional quality that one of them is the preferred choice (Figure 2). Of the two specimens available we chose *Burchell* 4482 (a whole plant) rather than *Burchell* 4564 (an inflorescence and two separate leaves), because the former gives a better idea of the appearance of the plant.

Aloe schmidtiana Regel in *Gartenflora* t. 970 (1879). Holotype: *Gartenflora* 97: t. 970.

It is unlikely that a herbarium specimen was prepared of the leaf and flower material referred to in the protologue. A very attractive illustration depicting *A. cooperi* Baker, however, accompanies the protologue. Since this plate is the one illustration used by the author (Art. 9.3 of the *International Code of Botanical Nomenclature*) it is here treated as the holotype.

Aloe longistyla Baker in *Journal of the Linnean Society, Botany* 18: 158 (1880). Lectotype: Cape, Graaff-Reinet, *Bolus* 689 (K, lecto!; PRE, photo!, here designated).

Baker (1880) cites two specimens in the protologue of this species. The specimen *Bolus* 689 is chosen as lectotype rather than *Drège* 8640 because of its more detailed locality data (Figure 4).

Aloe aristata Haw. in *Philosophical Magazine* 66: 280 (1825). Neotype: Cape, near Steynsburg, *Reynolds* 1024 (PRE!, here designated).

Aloe longiaristata Schult. & Schult. f. in *Systema vegetabilium* 7,1: 684 (1829). Neotype: Salm-Dyck, *Monographia generum Aloë et Mesembryanthemi*, Fasc. 2, fig. 21 [Sect. 15, fig. 7 (1837), here designated].



FIGURE 2.—Both *Burchell* specimens, 4482 and 4564, are mounted on the same sheet. The neotype of *Aloe micracantha*, *Burchell* 4482, is the complete one in the middle (arrowed).



FIGURE 3.—Reduced photograph of an unpublished painting of *Aloe micracantha* by an unknown artist, probably not Franz Bauer as claimed by Reynolds (1950) (G. Ll. Lucas pers. comm.). Reproduced with permission of the Controller, Her Majesty's Stationery Office, and The Trustees, Royal Botanic Gardens, Kew.

As usual, Haworth gives no clue as to what material he had available when drawing up his description of *A. aristata*. In the absence of any contemporary or near-contemporary illustrations or specimens (no published reference was made to the name for 70 years after the protologue), a good modern specimen, *Reynolds 1024*, is chosen as neotype (Figure 5). One of its synonyms, *A. longiaristata*, is another name that is not in general use in the current taxonomy of the genus. However, it shows clearly how in the previous century names were based on etiolated plants grown *ex situ* thousands of miles away from their natural habitats (Salm-Dyck 1837). The plate chosen here as neotype of the name is the only obvious one that can serve the purpose. J. A. & J. H. Schultes (1829) inexplicably included the validly published name, *A. aristata*, in the synonymy of *A. longiaristata*.

***Aloe humilis* (L.) Mill. var. *incurva* Haw.** in Transactions of the Linnean Society 7: 15 (1804). Neotype (icono.): Curtis's Botanical Magazine 21: t. 828 (1805), here designated.

This is another case where a neotype is chosen for a name considered to be a synonym of another—the varieties of *A. humilis* intergrade so thoroughly as not to be worth upholding. Haworth (1804) has here, as is often the case, supplied no hint of the material he saw. Ker Gawler (1805) tells us that his plant came from a nursery in Kensington, which must surely have been known to Haworth, who at that time lived in Chelsea in the same part of the then southwestern outskirts of London. Again, the earliest available element is chosen, to stabilize current usage.

***Aloe glauca* Mill.** in The Gardeners' Dictionary No. 16 (1768). Neotype: Cape, hills south of Wyke, *Reynolds 1967* (PRE!, here designated).

Miller's protologue (1768) of this species gives a reference to a plate in Commelin (1703), which Wijnands (1983) shows clearly to represent a completely different species. Miller gives no other indication of a type for this name. As Wijnands (1983) points out, one is faced in this case with a choice of two options, both of which have undesirable features, namely: 1, drawing the conclusion from the evidence so ably marshalled by Wijnands (1983) that Miller suffered a series of errors at the crucial point here, and stabilize current usage by conserving the name *Aloe glauca* Mill. with a completely new type, rejecting all references to his confused citation of Commelin illustrations; or 2, reject this well known name as a *nomen confusum* in favour of the next-oldest, securely identified name, *A. rhodacantha* DC. It seems to us that the first course is the less harmful, and so neotypes are proposed here for both *A. glauca* Mill. (Figure 6) and *A. muricata*



FIGURE 4.—*Bolus 689*, lectotype of *Aloe longistyla*.



FIGURE 5.—Reynolds 1024, neotype of *Aloe aristata*.

Schult., the basionym of one of its infraspecific taxa (Figure 7; see below).

***Aloe glauca* Mill. var. *muricata* (Schult.) Baker** in *Journal of the Linnean Society* 18: 161 (1880). Neotype: Cape, Piketberg Division, De Hoek, *Reynolds* 4749 (PRE!; SAM! isoneo.)

A. muricata Schult. in *Observationes botanicae*: 70 (1809).

No type is cited for *A. muricata* Schult. and, as in the previous case, neotypification stabilizes current usage of the name.

***Aloe saponaria* (Aiton) Haw. var. *latifolia* Haw.** in *Transactions of the Linnean Society* 7: 18 (1804). Neotype (icono.): Ker Gawler in *Curtis's Botanical Magazine* 34: t. 1346 (1811), here designated.

It is proposed here that the name should be included in the synonymy of *Aloe maculata* All. Ker Gawler (1811) states 'We have to thank Mr Haworth for the present specimen.' Although Haworth (1804), as usual, gives no clue as to the material he described under var. *latifolia*, it would be taking caution altogether too far to assume that the plant figured was not at least part of the material of this taxon known to Haworth at the time he coined the name.

***Aloe striata* Haw.** in *Transactions of the Linnean Society of London* 7: 18 (1804). Neotype: Cape, near Grahamstown, *Bottomley s.n.* in PRE 27 (PRE!), here designated.

Haworth (1804) mentions, in a cryptic note, a Masson plant we have had no success in tracing. One must therefore assume that this specimen, if it ever existed, has long since disappeared and a neotype may therefore be chosen. This is done here in such a way as to stabilize current usage. The specimen chosen is mounted on two sheets; to obviate future confusion we designate the sheet shown in Figure 8 as 'lectoneotype.'

***Aloe thorncroftii* Pole Evans**

In the introduction to a paper in which he describes several species of *Aloe* that are now well known, Pole Evans (1917) states that 'the accompanying descriptions have been made from plants growing in the rockeries in the grounds of the Botanical Laboratories of the Union of South Africa'; that is, the lower western part of the Union Buildings garden in Pretoria. He gives a collector and locality (sometimes more than one) for each species, but never cites a specimen number. This makes locating the intended type specimen somewhat problematical in some cases.



FIGURE 6.—Reynolds 1967, neotype of *Aloe glauca*.

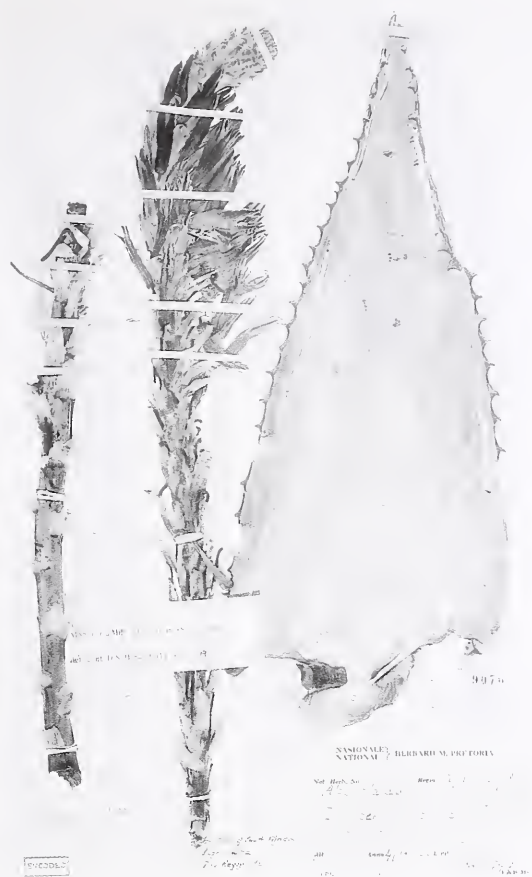


FIGURE 7.—Reynolds 4749, neotype of *Aloe muricata*.

The protologue of *Aloe thorncroftii* forms part of Pole Evans's paper, and in this case the only indication of a type is the following paragraph: 'All the plants (7) which so far have been flowered in Pretoria have borne an unbranched inflorescence, but Mr George Thorncroft, who first sent me specimens of this *Aloe* and after whom it has been named, writes me that the inflorescence is branched in the case of some plants.'

One deduces that the type specimen of this species, if one exists, would be marked as having been collected by Thorncroft before 1917, and possibly as having been grown in the Union Buildings grounds. As there are no other specimens from the Union Buildings gardens known in any herbarium except PRE, and as Pole Evans was Chief of the then Division of Botany (later renamed the BRI and finally the NBI), one would search only in PRE for such a specimen. Such a search was undertaken in the course of studies on the southern African species of *Aloe* by the senior author. Only one specimen fitting these requirements was found (Figure 9). The label is typical of the Pole Evans period, and matches those of many specimens giving their locality only as 'Union Buildings gardens.' The specimen was collected by Thorncroft in 1914 (long enough before the date of publication to allow quite a small plant to grow to flowering size), and is numbered 247 in an unknown series. Neither Pole Evans's collecting register nor the PRE accessions register has a

species of *Aloe* as No. 247, therefore one wonders if the number is from the accessions register of the Vredehuis Garden (predecessor to the Pretoria National Botanical Garden). No register of this date from this garden has survived. It seems that this is the type specimen of *Aloe thorncroftii* and its correct citation is: TYPE: Transvaal, Barberton, 1914, *G. Thorncroft s.n.* in PRE 247 (PRE, holo.!).

***Aloe pluridens* Haw.** in The Philosophical Magazine 64: 299 (1824). Neotype: Cape, Ettrick Hills near Carlisle Bridge, *Reynolds 1425* (PRE!, here designated).

As usual, Haworth gives no clue as to what material he had available when drawing up his description of this species. Just as in the case of *A. aristata*, this name was ignored in print for 70 years after the publication of the protologue. In the absence of any contemporary or near-contemporary illustrations or specimens, a good modern specimen is chosen as neotype (Figure 10).

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FIGURE 8.—Bottomley s.n. (PRE 27), neotype of *Aloe striata*.



FIGURE 9.—*Thomcroft s.n. (PRE 247)*, holotype specimen of *Aloe thomcroftii*.



FIGURE 10.—*Reynolds 1425*, neotype of *Aloe pluridens*.

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Solanum (Solanaceae) in Uganda

Z.R. BUKENYA* and J.F. CARASCO**

Keywords: food crops, indigenous taxa, key, medicinal plants, ornamentals, *Solanum*, Solanaceae, Uganda, weeds

ABSTRACT

Of the 41 species, subspecies and cultivar groups in the genus *Solanum* L. (Solanaceae) that occur in Uganda, about 30 are indigenous. In Uganda several members of the genus are utilised as food crops while others are put to medicinal and ornamental use. Some members are notorious weeds. A key to the species and descriptions of all *Solanum* species occurring in Uganda are provided.

UITTREKSEL

Van die 41 spesies, subspesies en kultivargroepe in die genus *Solanum* L. (Solanaceae) wat in Uganda voorkom, is sowat 30 inheems. Verskeie lede van die genus word as voedselgewasse benut, terwyl ander vir geneeskundige en ornamentele gebruike aangewend word. Sommige lede is welbekend as onkruid. 'n Sleutel tot die spesies en beskrywings van al die *Solanum*-spesies wat in Uganda voorkom word voorsien.

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INTRODUCTION

The genus *Solanum* L. belongs to the family Solanaceae, and contains about 2 000 species of which about 35 occur in Uganda. Several species are important food crops, yielding edible fruits and leaves whereas others are ornamentals or weeds (Heine 1963).

The genus also contains plants of medicinal value. For example the fruits of *S. anguivi* Lam. contain alkaloids used in the treatment of a number of diseases including chronic respiratory diseases (Bector *et al.* 1971). Walters (1965) observed that *Solanum* alkaloids have antifungal effects. Thus it is possible that some of these alkaloids could be used as antibiotics. Beaman-Mbaya & Muhammed (1976) reported that alkaloids from fruits of *S. incanum* L. are used in treatment of cutaneous mycotic infections and other pathological conditions in Kenya. In Uganda, the soup from green fruits of *S. anguivi* Lam. is popular especially among women, for it is believed to cure hypertension (Sengendo 1982).

The genus is widely distributed throughout the world with major species representation in America, Australia and Africa. The genus was first studied by Dillenius (1732) and later by Linnaeus (1753). Since 1753 the genus has been reclassified innumerable times and a multitude of varieties, subspecies and species have been named, especially in the section *Solanum*. For example, Dunal (1813) in his monograph of the genus, described 60 species belonging to section *Solanum*. Bitter (1912, 1913, 1917, 1919, 1921, 1922, 1923) was the second worker to attempt to monograph the genus; he is criticized for being

'more of a splitter than Dunal, and he described more than 60 new *Solanum* species from the Americas alone' (Edmonds 1977). He recognised 20 sections for the genus, and revised *Solanum* in Africa utilizing mainly collections from German expeditions. He erected a partial classification of *Solanum*.

The validity of some of Bitter's varieties has been questioned because they were based on minor variations which are of very limited taxonomic value. However, his work is the most detailed treatment so far available on African *Solanum*.

D'Arcy (1972) provided a modern classification of the genus *Solanum* into subgenera, sections and series and his classification is widely accepted today. It is also followed here.

Although the above major works and others attempted to streamline the taxonomy of *Solanum*, the genus is taxonomically difficult, due to various factors. These include the difficulty of associating the names of *Solanum* used by earlier taxonomists with plants of today due to early descriptions being brief, often vague and frequently lacking in characters now considered to be diagnostic. Another problem is that some of the early names, for example many of the names of Linnaeus and those before him, are difficult to typify (Hepper 1979).

Another problem is the occurrence of polyploid series within the section *Solanum* (Edmonds 1977), such as tetraploids and hexaploids occurring within the *S. nigrum* complex. These may provide a barrier to hybridization

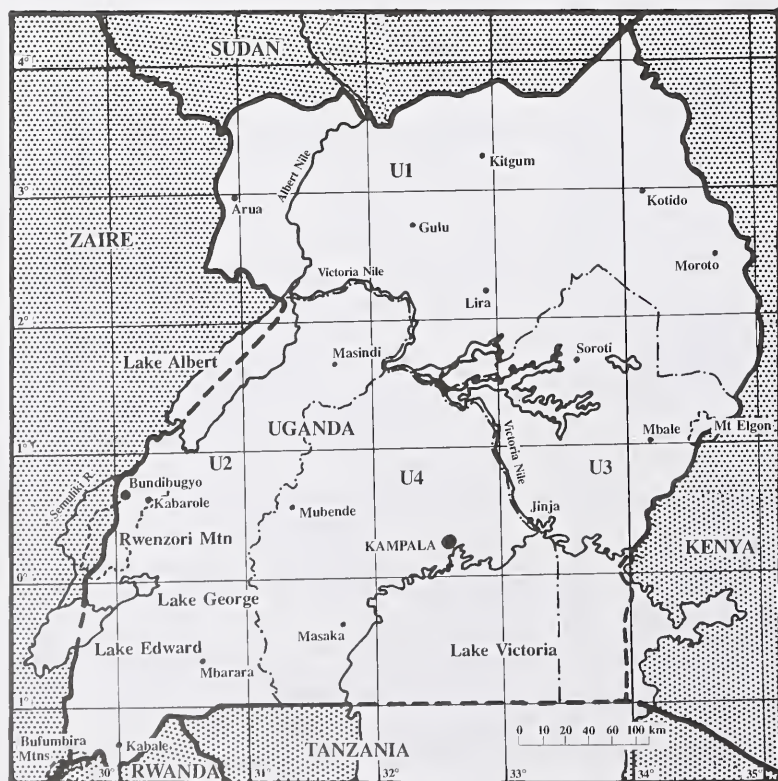


FIGURE 1.—Geographical divisions, U1, U2, U3 and U4, of the *Flora* of tropical East Africa and the main towns of Uganda.

between morphologically similar plants leading to cytoraces which are difficult to differentiate using classical methods.

There is also considerable phenotypic plasticity within species and hybridization between closely related species. Hybridization followed by inbreeding may result in formation of new populations different from either parent. This is particularly true for the cultivated species, as for example found in sections *Melongenae* and *Oliganthes*. A large number of 'microspecies' or 'semispecies' (Grant 1971) occur in section *Solanum* and it is difficult to decide which of these deserve taxonomic recognition.

In recent years, there has been an explosion of data from various taxonomic research projects aimed at attempting to solve some of the above problems and improving the knowledge of the genus. The majority of these studies has been made outside Africa. Jaeger (1985) recognized 80 species of *Solanum* in Africa. To a large extent we accept the taxonomic treatment of the taxa he discussed. The information in this work, especially on typification and synonymy, was very useful in the present study. No comprehensive taxonomic study had been made on the genus in Uganda. Lind & Tallantire (1975) provided short descriptions of only three Ugandan species of *Solanum*, i.e. *S. terminale* Forssk., *S. incanum* L. and *S. nigrum* L. Sengendo (1982) produced some data on the two species *S. anguivi* and *S. aethiopicum* L., while

Bukenya (1991) gave a comparative account of a few *Solanum* fruit and leaf vegetables.

To date the Solanaceae has not yet been treated for the *Flora of tropical East Africa*. Hence, to identify a species of *Solanum* in Uganda one has to use other regional floras, particularly the *Flora of tropical West Africa*, edn 2 (Heine 1963). However in this Flora, not all the species of *Solanum* occurring in Uganda are included and the descriptions of species are brief.

It was necessary to carry out a comprehensive study of these species so that critical descriptions and a key to the species could be provided.

MATERIALS AND METHODS

The species descriptions were largely based on the study of herbarium material in the Botany Department, Makerere University; the Royal Botanic Gardens, Kew; the Forest Herbarium, Oxford, and the Institute of Systematic Botany, Munich.

Figure 1 shows the map of Uganda divided into the four geographical divisions of the *Flora of tropical East Africa*. Table 1 gives the infrageneric classification of Ugandan *Solanum* species based on D'Arcy (1972).

Key to species

1a Plants usually armed:

2a Hairs stellate:

4a Mature leaves \pm glabrous; inflorescence corymbose, cyme subfasciculate or paniculate:

5a Leaves \pm 280 \times 120 mm; inflorescence paniculate 31. *S. giganteum*

5b Leaves $<$ 200 \times 80 mm; inflorescence cymose or corymbose:

6a Inflorescence cymose; flowers often subumbellate or branched, peduncle 10–20-flowered; leaves up to 150 \times 70 mm 32. *S. kagehense* group

6b Inflorescence corymbose, 20–50-flowered; leaves 50–80 \times 30–40 mm 33. *S. renschii*

4b Mature leaves mostly hairy; flowers solitary or inflorescence few-flowered, racemose, lateral:

7a Fruit dry, usually completely enclosed by heavily armed accrescent calyx, seeds shiny black 23. *S. coagulans*

7b Fruit not dry, seeds yellow-brown:

8a Corolla 17–45 mm long; fruit 20–130 \times 30–100 mm:

9a Fruit red when mature; prickles absent or present on young leaves 25a. *S. aethiopicum* Gilo group

9b Fruit yellow when mature:

10a Plants 4–10 m high:

11a Leaves about 150 \times 100 mm, upper surface glabrous 19. *S. aculeastrum*

11b Leaves up to 300 \times 240 mm, both surfaces hairy 22. *S. wrightii*

10b Plants $<$ 4 m high:

12a Petiole $<$ 30 mm long; prickles present or absent 21. *S. marocarpum*

12b Petiole 40–70 mm long; prickles present or absent:

13a Prickles almost always absent; fruit 60–130 \times 30–100 mm 18. *S. melongenae*

13b Prickles always present; fruit 27 \times 30 mm 20. *S. incanum*

8b Corolla 10–15 mm long; fruit 8 \times 10 mm:

14a Leaves glabrous; corolla 5–7 mm long; fruit \pm 15 mm diam. 25b. *S. aethiopicum* Shum group

14b Leaves hairy; corolla $>$ 7 mm long; fruit $<$ 15 mm diam.:

15a Plants clambering or scandent:

16a Inflorescence racemose, 3–10-flowered 27. *S. cyaneopurpureum*

16b Inflorescence not racemose:

17a Inflorescence umbelliform, 2–6(–10)-flowered; leaves ovate 28. *S. hastifolium*

17b Inflorescence (1) 2–4-flowered; leaves lanceolate 29. *S. taitense*

15b Plants not clambering or scandent:

18a Leaves rather small, 20–70 \times 10 mm; fruits yellow when ripe 26. *S. albicaule*

18b Leaves 100–200 \times 50–150 mm; fruits red when ripe:

19a Plants generally non-prickly, occasionally a few prickles present; flowers solitary or 5–15 in a raceme-like cyme 24. *S. anguivi*

19b Plants heavily armed with prickles; inflorescence 8- to many-flowered, rachis simple or branched, racemose 30. *S. usambarense*

- 2b Hairs simple, sometimes glandular or absent, occasionally with stellate hairs interspersed:
 20a Plants climbing; leaves compound; inflorescence many-flowered (50+), inflorescence axis very long, ± 300 mm 17. *S. wendlandii*
 20b Plants not climbing; leaves simple; inflorescence few-flowered (< 10), a short unbranched raceme:
 21a Corolla violet or blue, ± 12 mm long; fruit with terminal nipple or mamilla 15. *S. mammosum*
 21b Corolla white, ± 17 mm wide; fruit with no terminal nipple or mamilla 16. *S. aculeatissimum*
- 1b Plants mostly unarmed;
 3a Hairs stellate; fruits pubescent 14. *S. mauritianum*
 3b Hairs simple, sometimes branched or glandular, or absent; fruits not pubescent:
 22a Leaves compound:
 23a Tuberous stolons present; plant not climbing; inflorescence with simple hairs; fruits ± 7 mm diam. 34. *S. tuberosum*
 23b Tuberous stolons absent; plant climbing; inflorescence glabrous; fruits ± 10 mm diam. 35. *S. seaforthianum*
 22b Leaves not compound:
 24a Plants herbaceous < 2 m high:
 25a Fruiting calyces strongly adherent-acrescent, enclosing at least lower half of berries 4. *S. sarrachoides*
 25b Fruiting calyces only slightly acrescent, reflexed or adhering to base of berries:
 26a Berries longer than broad, yellow, orange or red 5. *S. villosum*
 26b Berries globose or broader than long, black, purple or green:
 27a Inflorescence branched, up to 20-flowered 7. *S. florulentum*
 27b Inflorescence not branched, less than 20-flowered:
 28a Inflorescence racemose 8. *S. tarderemotum*
 28b Inflorescence an umbellate cyme:
 29a Leaves glabrous, up to 250×200 mm 3. *S. scabrum*
 29b Leaves not glabrous, less than 150×100 mm:
 30a Fruiting pedicel erect; seeds 1×1 mm 2. *S. americanum*
 30b Fruiting pedicel recurved:
 31a Corolla about 10 mm diam. 1a. *S. nigrum* subsp. *nigrum*
 31b Corolla about 15 mm diam. 6. *S. grossedentatum*
- 24b Plants shrubs 2–7 m high:
 32a Inflorescence a lax cymose panicle:
 33a Leaves hairy on both surfaces 13. *S. rumsoriense*
 33b Leaves more or less glabrous 12. *S. benderianum*
 32b Inflorescence spiciform, umbellate or subracemose:
 34a Erect subshrub; stem verrucose; leaves $20\text{--}70 \times 10\text{--}40$ mm; inflorescence umbellate, 5–10(–20)-flowered 11. *S. nakurense*
 34b Climbing shrubs; stem not verrucose; leaves $80\text{--}170 \times 40\text{--}80$ mm; inflorescence various, (2–7)–50-flowered:
 35a Inflorescence terminal, spiciform, up to 200 mm long 10. *S. welwitschii*
 35b Inflorescence not spiciform:
 36a Inflorescence subracemose, leaf-opposed or in leaf axil, 2–7-flowered 9c. *S. terminale* subsp. *inconspans*
 36b Inflorescence not as above, many-flowered:
 37a Peduncles with terminal umbel, sometimes a few lateral ones as well; inflorescence sometimes with more than 50 flowers 9a. *S. terminale* subsp. *terminale*
 37b Peduncle terminal or subterminal, strongly branched, giving inflorescence a panicle appearance 9b. *S. terminale* subsp. *sanaganum*

Solanum L., Species plantarum: 184–188 (1753); L.: 85 (1754); D'Arcy: 85 (1973).

Section **Solanum** Seithe in Botanische Jahrbücher 81: 261–336 (1962).

The genus is recognized by the 5-partite calyx and by long, often connivent anthers dehiscing by terminal pores and with short filaments. Other characters useful for recognition are the frequently rotate, 5-lobed corolla, the fruit being a berry with flattened seeds; the often stellate-pubescent prickles; and the often extra-axillary, usually cymose inflorescence.

A. Subgenus **Solanum** D'Arcy in Annals of Missouri Botanical Garden 60: 733 (1973). Type species: *S. nigrum* L.

Leaves subentire or shallowly lobed, often membranaceous; indumentum simple, hairs rarely branching. *Prickles* absent. *Flowers* mostly small. *Corolla* mostly deeply lobed. *Filaments* often pubescent; *anthers* short, dehiscing introrsely by large, often oblique terminal pores and sometimes ultimately by longitudinal slits in the upper portion. *Ovary* glabrous. *Fruit* rather small, 7–15 mm diam.

The subgenus is represented in Uganda by three sections: *Solanum*, *Afrosolanum* and *Benderianum*.

1. **Solanum nigrum** L., Species plantarum: 186 (1753); Heine: 335 (1963); E.M. Lind & Tallantire: 130 (1975); Hepper: 12 (1976). Type: LINN 248.18 (IDC microf. 1775 138: III.4). All the above authors have taken *S. nigrum* in a broad sense.

Herb, about 1 m high. *Leaves* ovate-elliptic, 60–100 \times 40–70 mm; lamina glabrous when mature, margin entire or toothed, repand or with 2 or 3 pairs of short lobes; petiole 10–30 mm long. *Inflorescence* 6–8-flowered; peduncle ± 10 mm long; pedicels ± 5 mm long. *Corolla* 3–4 mm long. *Fruit* usually broadly ovoid, 5–8 mm diam., shiny black when ripe; fruiting pedicel ± 10 mm long, recurved. *Seeds* $\pm 1 \times 2$ mm.

The name *S. nigrum* has been used in Uganda in a broad sense until the work of Edmonds (Gray 1968; Edmonds 1971, 1972) and Jaeger (1985). Edmonds, at Oxford University, identified some of the specimens from the Botany Department herbarium, Makerere. Studies of this complex were carried out with specimens from Uganda, kept at Kew Herbarium and at Makerere Herbarium. Those studies have led to the recognition of eight Ugandan taxa

TABLE 1.—Infrageneric classification of Ugandan *Solanum* spp. based on D’Arcy (1972)

<i>Solanum</i> spp.	Subgenus	Section
1. <i>nigrum</i>	<i>Solanum</i>	<i>Solanum</i>
2. <i>americanum</i>	"	"
3. <i>scabrum</i>	"	"
4. <i>sarrachoides</i>	"	"
5. <i>villosum</i>	"	"
6. <i>grossedentatum</i>	"	"
7. <i>florulentum</i>	"	"
8. <i>tarderemotum</i>	"	"
9. <i>terminale</i>	"	<i>Afrosolanum</i>
10. <i>welwitschii</i>	"	"
11. <i>nakurense</i>	"	"
12. <i>benderianum</i>	"	<i>Benderianum</i>
13. <i>runsoriense</i>	"	"
14. <i>mauritanium</i>	<i>Brevantherum</i>	<i>Brevantherum</i>
15. <i>mannosum</i>	<i>Leptostemonum</i>	<i>Acanthophora</i>
16. <i>aculeatissimum</i>	"	"
17. <i>wendlandii</i>	"	<i>Aculeigerum</i>
18. <i>melongena</i>	"	<i>Melongena</i>
19. <i>aculeastrum</i>	"	"
20. <i>incanum</i>	"	"
21. <i>macrocarpon</i>	"	"
22. <i>wrightii</i>	"	"
23. <i>coagulans</i>	"	<i>Monodolichopus</i>
24. <i>anguivi</i>	"	<i>Oliganthes</i>
25. <i>aethiopicum</i>	"	"
26. <i>albicaule</i>	"	"
27. <i>cyaneopurpureum</i>	"	"
28. <i>hastifolium</i>	"	"
29. <i>taitense</i>	"	"
30. <i>usambarense</i>	"	"
31. <i>giganteum</i>	"	<i>Torva</i>
32. <i>kagehense</i> group	"	"
33. <i>renschii</i>	"	"
34. <i>tuberosum</i>	<i>Potatoe</i>	<i>Potota</i>
35. <i>seafortianum</i>	"	<i>Jasminosolanum</i>

from the *S. nigrum* complex. These are *S. nigrum* subsp. *nigrum*, *S. americanum* Mill., *S. scabrum* Mill., *S. sarrachoides* Sendtn., *S. villosum* Mill., *S. grossedentatum* A. Rich., *S. florulentum* Bitter and *S. tarderemotum* Bitter.

1a. ***S. nigrum* L. subsp. nigrum**; Edmonds: 141–178 (1977).

Herb about 1 m high, with abundant mostly appressed simple hairs when young, subglabrescent when mature. *Stem* robust. *Leaves* usually bearing simple hairs on both surfaces and margin; margin repand or crenate with teeth \pm 3 mm long; petiole 20–35 mm long. *Inflorescence* lateral, lax cymes, 6–8-flowered. *Corolla* \pm 4 mm long. *Fruit* \pm 7 mm diam.; fruit stalk decurved, deep purple to shiny black when ripe. *Seeds* \pm 1 \times 2 mm. 2n = 72 (Edmonds 1977). *Pollen* diam. 25.1–28 μ m.

This subspecies and *S. nigrum* as a whole constitute a Eurasian taxon. It has, however, spread to all other continents. The leaves are eaten in Uganda. Fruits are, however, reported to be poisonous (FAO 1988).

Vouchers: U1: Karamoja, fl. & fr. Jan. 1958, *Beadle* 8. U3: Busoga (0° 15', 33° 54') fl. Sept/ 1973. *Wandera* 10. U4: 0.5 km E of Port Bell Pier, fl. & fr. Jan. 1969, *Lye* 1155.

2. ***Solanum americanum* Mill.** in Gardener’s dictionary edn 8: (1768); D’Arcy: 735 (1973); Edmonds: 141–178 (1977). Type: cultivated Chelsea Physic Garden, introduced from Virginia, North America, *Miller s.n.* (BM).

The names *S. nodiflorum* Jacq. and *S. nigrum* L. have been widely and incorrectly used for this species. A detailed list of synonyms has been given by Edmonds (1972, 1979a).

Herb about 1 m high. *Stem* with simple hairs when young, glabrous when mature. *Leaves* 50–130 \times 30–60 mm; mature lamina glabrous, margin repand or with 2–3 pairs of lobes, \pm 5 mm long; petiole up to 50 mm long. *Inflorescence* lateral, umbellate cymes 2–10-flowered; peduncle up to 30 mm long. *Corolla* \pm 3 mm long, up to 10 mm wide. *Fruit* globose, up to 9 \times 10 mm, shiny black when ripe; fruit stalk 10–13 mm long, erect. *Seeds* 1 \times 1 mm. 2n = 24 (Edmonds 1977). *Pollen* diam. 17.7–19.2 μ m.

S. americanum is a morphologically variable species. Edmonds (1977) divided it into two varieties, i.e. var. *americanum* and var. *patulum* (L.) Edmonds. The former is pilose and the latter glabrescent.

S. americanum is an introduced weed. Its leaves are collected and eaten. It occurs in all the four geographical regions of Uganda. It is also widely distributed throughout Africa and around the world. It is of South American origin, probably recently introduced into Africa. It is believed to have donated at least 2 genomes to the hexaploid *S. nigrum* L. (Edmonds 1979b).

Vouchers: U1: Maraca Kijomoro W. Nile, fl. & fr. May 1971. *Batia* 19. U2: Rwenzori Mtn, fl. Aug. 1938, *Purseglove* 308. U3: Nakaloke Mbale, fl. Aug. 1991, *Bukenya* 136. U4: M. 12 Kila-Ebb Rd, fl. & fr. May 1932, *Eggeling* 414.

3. ***Solanum scabrum* Mill.** in Gardener’s dictionary edn 8: (1768); Edmonds: 141–178 (1977). Type: cultivated Chelsea Physic Garden, origin North America, *Miller s.n.* (BM) (fide Henderson 1974).

The synonymy has been discussed by Henderson (1974) and Edmonds (1979a).

Bushy subshrub 1.0–1.5 m high. *Stem* with simple hairs when young, glabrous when mature. *Leaves* up to 250 \times 200 mm; lamina glabrous; petiole up to 70 mm long. *Inflorescence* lateral, umbellate to racemose cymes, usually 6–23-flowered, often more; peduncle 20–25 mm long; pedicel \pm 5 mm long. *Corolla* \pm 7 \times 15 mm. *Anthers* purplish brown. *Fruit* broadly ovoid, 13 \times 17 mm, dull purple-black when ripe; fruit stalk erect or recurved 30–40 mm long. *Seeds* 1 \times 1 mm. 2n = 72 (Edmonds 1977).

S. scabrum is a rare species in Uganda and is recorded only from the extreme southwestern part. Its leaves are eaten. In other parts of Africa, the West Indies and Indonesia, it is cultivated for its leaves and young shoots (FAO 1988). The fruits are eaten in Europe, where it is known as ‘garden huckleberry’.

Its origin is unknown (Edmonds 1979b). Some authors, however, describe it as a native of Guinea. Heine (1960) has pointed out that *S. scabrum*, 'does not occur wild in Guinea, but is cultivated there as a pot-herb and for medicinal purposes; nor apparently is it a native of any part of Africa'. Morphologically it is distinct and genetically isolated from other hexaploid solanums (Edmonds 1979b).

Vouchers: U2: Kigezi D.F.I., fl. & fr. Aug. 1972, *Goode 3/72*; Bugangiri Ruzhumbura Kigezi, fl. & fr. Feb. 1949, *Purseglove 2712*.

4. *Solanum sarrachoides* Sendtn. in Martius, *Flora braziliensis* 10: 18 (1846). Types: Brazil, *Sellow s.n.* (B†; P, lecto.) (fide Edmonds 1972, 1986). The typification of this species is discussed by Edmonds (1986).

The synonymy is discussed by Edmonds (1972, 1986).

Erect and spreading herb up to 750 mm high with dense glandular hairs. *Leaves* ovate, sinuate dentate, 30–70 mm × 15–40 mm. *Cymes* simple, shortly racemose, 3–8-flowered. *Flowers* up to 10 mm diam. *Fruiting pedicels* reflexed; fruiting calyces strongly adherent, accrescent, enclosing at least the lower half of the fruit. *Fruit* green to brownish purple when mature, less than 9 mm diam. $2n = 24$ (Edmonds 1972).

S. sarrachoides is a relatively rare species in Uganda. It is not edible. It is originally from South America but now established across tropical Africa and naturalized in Europe.

Edmonds (1979b) suggested that this species might be a diploid progenitor of the tetraploid *S. villosum* Mill. and therefore may have played a role in the origin of *S. nigrum* L. It is morphogenetically completely isolated from all other diploid solanums (Edmonds 1977).

Vouchers: U2: nr footbridge, Nyabitaba Rwenzori, fl. Jan. 1969, *Lye 1365*; Kigezi D.F.I., fl. & fr. Aug. 1972, *Goode 5/72*. U3: N.E. Elgon, fl. & fr. Nov. 1951, *Tweedie 1068*.

5. *Solanum villosum* Mill. in Gardener's dictionary edn 8: (1768). Type: cultivated Chelsea Physic Garden, introduced from Barbados. *Miller s.n.* (BM). [Lectotype fide Edmonds 1979a; neotype fide Henderson (1977)].

Erect herb, sometimes woody, much branched, up to 0.9 m high, glabrescent to villose, with glandular or eglandular hairs. *Leaves* ovate, entire or dentate 30–100 × 15–40 mm. *Inflorescence* simple, 3–9-flowered; flowers 10–17 mm diam. *Fruiting pedicels* usually deflexed. *Fruit* longer than broad, 6–10 mm diam., yellow, orange or red. $2n = 48$ (Edmonds 1977).

Edmonds (1977, 1984) subdivided *S. villosum* into two subspecies: subsp. *villosum* and subsp. *miniatum* (Bernh. ex Willd.) Edmonds. The former has dense, mostly patent glandular hairs whereas the latter has few to many appressed eglandular hairs. *S. villosum* is believed to have hybridized with *S. americanum* and given rise to a sterile triploid which through chromosome doubling gave rise to *S. nigrum* (Edmonds 1979b). The origin of *S. villosum* is not clear. Stebbins (1950) speculated that *S. americanum* might have played a role in its origin. Edmonds (1979b)

suggested the possibility of *S. sarrachoides* being the second parent of *S. villosum*.

S. villosum is native to Europe. It has become established in Africa. In Uganda it occurs in three of the four geographical regions. Its leaves are eaten as spinach.

Vouchers: U1: Moroto Mtn, fl. & fr. Jan. 1959, *Wilson 633*; Kidepo N.P. Dodoth, fr. Jan. 1973, *Synnott 1404*. U2: Ruizi R., fl. & fr. Apr. 1951, *Jarrett 454*. U3: Bujagali Falls, Jinja, fl. & fr. July 1952, *Lind 82*.

6. *Solanum grossedentatum* A. Rich., *Tentamen florae abyssinicae* 2: 101 (1850). Type: Ethiopia, 'crescit in provincia Tchelikote', A. Petit s.n. (P).

Semiprocumbent herb up to 700 mm high, villose with rust-coloured hairs. *Leaves* ovate, dentate to incised, 30–70 × 20–40 mm. *Cymes* simple, subumbellate, 3–4-flowered, pedicels reflexed. *Corolla* about 15 mm diam. *Fruiting pedicels* reflexed. Ripe fruit black.

S. grossedentatum seems to be native to Africa. Its ploidy level is unknown.

In Uganda it is fairly widely distributed, occurring in three of the geographical regions. It is a crop weed. The leaves are used as a vegetable and the fruits eaten by children.

Vouchers: U1: Païda W. Nile, fl. & fr. Aug. 1953, *Chancellor 185*. U2: Muhokya Rwenzori, fl. Dec. 1925, *Maitland 1290*. U3: Budadiri Bugishu, fl. & fr. Jan. 1932, *Chandler 405*.

7. *Solanum florulentum* Bitter in Feddes Repertorium 10: 544 (1912). Type: Tanzania, *Albers 189* (B†, EA?).

Scrambling herb, up to 1.5 m high, sparsely pubescent with simple hairs. *Leaves* ovate to lanceolate up to 100 × 60 mm, petiole up to 20 mm long. *Inflorescence* branched once, racemose, 8–20-flowered; inflorescence stalk ± 17 mm long; pedicels ± 8 mm long. *Corolla* 6–10 mm wide, lobes ± 3 mm long. *Fruit stalk* reflexed, ± 10 mm long. *Fruit* globose, 6 × 6 mm, purple to black when ripe. Ploidy level unknown.

S. florulentum is fairly common in geographical regions U2 and U4 of Uganda and it seems to be native to East Africa. Its leaves are eaten. It has been confused with *S. nodiflorum* Jacq. and *S. nigrum* L. *sensu lato*.

Vouchers: U2: Kigezi D.F.I., fl. & fr. Aug. 1972, *Goode 2/72*. U4: Kituza, 35 ml SE of Kila, fl. & fr. June 1957, *Griffiths 47*.

8. *Solanum tarderemotum* Bitter in Feddes Repertorium 10: 547 (1912). Type: Tanzania *Winkler 3856* (WRS?).

Erect or scrambling herb, up to 2.5 m high, glabrous or sparsely pubescent with simple hairs. *Leaves* ovate to lanceolate, entire or sinuate-dentate, 70–180 × 35–70 mm. *Inflorescence* simple, racemose, 7–12-flowered. *Flowers* 7–9 mm diam. *Fruiting pedicels* reflexed. *Fruit* greenish yellow or purple when ripe, 4–6 mm diam. Ploidy level unknown.

S. tardereinotum is closely related to *S. florulentum* but differentiated from it by its simple inflorescence. It also seems to be native to East Africa. In Uganda it is represented in all the geographical regions. Its leaves are eaten.

Vouchers: U1: Terego W. Nile, fl. & fr. Apr. 1938, *Hazel* 486. U2: Kigezi D.F.I., fl. & fr. Aug. 1972, *Goode* 172. U3: Budadiri Bugishu, fl. & fr. Jan. 1932, *Chandler* 458. U4: Nakyesanja nr Kawanda, fl. & fr. Mar. 1972, *Damulira* 35.

Section **Afrosolanum** Bitter in Botanische Jahrbücher 54: 440–487 (1917); D'Arcy: 266, 274 (1972). Type species: *S. terminale* Forssk.

This is a rather difficult section, complicated by species plasticity and the existence of numerous specific and infraspecific names. Heine (1960) adopted a broad view of the species. He considered all material in this section from the FWTa (Heine 1963) area to be *S. terminale*. This was split into three subspecies: *inconstans*, *sanaganum* and *welwitschii*. Jaeger (1985) recommended three species for this section: *S. nakurense*, *S. terminale* and *S. welwitschii*. The subspecies of *S. terminale* are not very clear cut.

9. ***Solanum terminale* Forssk.**, Flora aegyptiaco-arabica: 45 (1775); Bitter: 301 (1922); Heine: 247 (1960). Type: Yemen, Mokhaja, *Forsskål s.n.* (C, IDC microf. 2200 102: II.3–6).

9a. ***Solanum terminale* Forssk. subsp. terminale** Heine in Kew Bulletin 14: 247 (1960).

The synonymy is discussed by Heine (1960, 1963) and Jaeger (1985).

Liana about 4 m tall. *Leaves* up to 110 × 65 mm, petiole up to 80 mm long. *Inflorescence* very many-flowered, often > 50 flowers; pedicels to ± 10 mm long; peduncles with terminal umbel, occasionally also with a few lateral umbels; lateral umbels subsessile or occasionally with the lowest on short branches. *Corolla* ± 8 mm long, whitish purple or bluish purple. *Fruit* globose, ± 8 mm diam., red when ripe.

Subsp. *terminale* is quite widely distributed in Uganda and eastern Africa from Ethiopia to South Africa.

Vouchers: U2: Kigezi, fl. Feb. 1956, *M.C.* 909; Kalinzu Forest, Igara, fr. June 1970, *Katende* 352. U3: Bunya, Busoga, fl. Nov. 1937, *Webb* 62. U4: 2 km E of Bujuko-Mubende Rd, fl. Feb. 1969, *Lye* 1950.

9b. ***Solanum terminale* subsp. sanaganum (Bitter)** Heine in Kew Bulletin 14: 248 (1960). Type: Cameroon, nr Deng Deng, *Mildbraed* 8619 (K!).

For synonymy see Heine (1960, 1963) and Jaeger (1985).

Climber about 6 m high. *Leaves* about 90 × 40 mm; petiole about 40 mm long. *Inflorescence* many(–50)-flowered; peduncles terminal or subterminal, strongly branched giving the inflorescence a paniculate appearance; pedicels ± 10 mm long. *Corolla* ± 8 mm long,

whitish purple. *Fruit* globose or slightly longer than wide, 8 × 6 mm.

Subsp. *sanaganum* is quite close to subsp. *terminale* in both vegetative and floral characters. The main difference between them is that the former has a paniculate, the latter an umbellate type of inflorescence. In Uganda it is less common than subsp. *terminale* but it is widely distributed in upland forests of tropical Africa.

Vouchers: U2: Echuya F.R. Kigezi, fl. Apr. 1970, *Katende* 221. U4: Entebbe, fl. & fr., *Brown* 14; Mabira Forest, fl. Feb. 1972, *Katende* 1526.

9c. ***Solanum terminale* subsp. inconstans (C.H. Wright) Heine** in Kew Bulletin 14: 247 (1960); Heine: 331 (1963); Gbile: 118 (1979). Syntypes: Fernando Po, *Mann* 62 (K); Cameroons, *Kalbrejer* 172 (K).

For synonymy see Heine (1960).

Slender woody climber. *Stem* flexuose with long internodes. *Leaves* up to 100 × 50 mm; petiole up to 18 mm long. *Inflorescence* subracemose, leaf opposed or in leaf axil; few (2–7)-flowered; peduncle up to 35 mm long; pedicel ± 14 mm long. *Corolla* 8–10 mm long. *Fruit* spindle-shaped, ± 25 × 10 mm; fruit stalk ± 28 mm long.

Subsp. *inconstans* is rare, found in disturbed forest. In Uganda it has been collected from Mabira Forest.

Vouchers: U4: Mabira Forest, fl. Sept. 1938, *Loveridge* 75.

10. ***Solanum welwitschii* C.H. Wright** in Kew Bulletin 1894: 126 (1894). Syntypes: Angola, *Welwitsch* 6081, 6098 (K!).

A list of synonyms is provided by Jaeger (1985).

Slender woody climber. *Leaves* elliptic, up to 170 × 80 mm; petiole up to 120 mm long. *Inflorescence* terminal, spiciform, up to 200 mm long; flowers > 50, bluish purple, in cymes, subsessile on axis. *Corolla* 8–10 mm long. *Fruit* globose, to 10 mm diam., red when ripe; fruit stalk to 6 mm long.

S. welwitschii is found in the forests of western and central Uganda. It also occurs in secondary forests of western tropical Africa.

Vouchers: U2: Siba Forest Kinkizi, fl. & fr. May 1951, *Dawkins* 751. U4: Mabira Forest, fl. Sept. 1933, *Bransnett s.n.*

11. ***Solanum nakurense* C.H. Wright** in Kew Bulletin: 275 (1897). Type: Kenya, Nakuru, *Scott Elliott* 6800 (K!).

For synonymy see Jaeger (1985).

Erect subshrub to 2 m high. *Stem* verrucose. *Leaves* variable, 20–70 × 10–40 mm, ovate, with scattered simple hairs on upper surface; lower surface sparse to densely hairy. *Inflorescence* umbellate; peduncle rarely branched, 5–10(–20)-flowered. *Flowers* white, orange to violet; corolla 6–10 mm long, to 15 mm diam.; pedicel to 12

mm long, strongly reflexed at anthesis. *Fruit* red, globose, 8 mm diam.

S. nakurense is morphologically similar to *S. terminale*. It differs from the latter by being erect, and having smaller leaves which are more hairy than in *S. terminale*. Its inflorescence is also generally simpler than in *S. terminale*.

S. nakurense is relatively rare in Uganda. It generally prefers the upland woodlands and open habitats.

Vouchers: U2: Kanaba gap Kabale-Kisoro, fl. Oct. 1960, *Miller 448*. U3: Namasindwa, Mt Elgon, fl. May 1924, *Snowden 889/a*; nr Kapkwata Forest St. Sebei, fl. Jan. 1969, *Lye 1571*.

Section **Benderianum** *Bitter* in *Botanische Jahrbücher* 54: 487–489 (1917). Type species: *S. benderianum* Schimp. ex Dammer.

12. *Solanum benderianum* Schimp. ex Dammer in *Botanische Jahrbücher* 38: 184 (1906). Syntypes: Ethiopia, near Gaffat, *Schimper 1227* (1863) (E); Uganda, Rwenzori Mts, *Scott Elliott 7733* (K!).

Climbing shrub. *Leaves* lanceolate, \pm glabrous. *Inflorescence* terminal, a lax cymose panicle with > 50 flowers. *Corolla* violet, \pm 20 mm diam.

The more or less glabrous *S. benderianum* is closely related to the hairy *S. runsoriense*. It is very rare in Uganda, only recorded from the Rwenzori Mts. It is common in Ethiopia, growing at an altitude of 2 500–3 600 m. *S. macrothyrsus* Dammer from the Comoro Islands is probably synonymous with *S. benderianum* (Jaeger 1985).

Voucher: U2: Rwenzori, fl. & fr. 1916, *Fyffe 20*.

13. *Solanum runsoriense* C.H. Wright in Johnston, *Uganda Protectorate* 1: 362 (1902). Type: Uganda, Rwenzori Mts, *Doggett s.n.* (K!).

Climbing shrub to 4 m high, with dense mealy pubescence of much branched hairs. *Leaves* lanceolate upper surface with light cover of mostly simple hairs; lower surface with a heavy cover of branched hairs. *Inflorescence* terminal, a lax cymose panicle with \pm 50 or more flowers. *Corolla* light blue to purple, \pm 20 mm diam.; *filaments* sometimes 3 mm long, *anthers* slightly longer, dehiscing by terminal pores and longitudinal slits running downwards from the pore.

S. runsoriense is a montane forest species occurring in Uganda on Rwenzori Mtn in the west and Mt Elgon in the east at or above the bamboo zone. It also occurs in Kenya at an altitude of 2 500–3 000 m.

Jaeger (1985) suggested that *S. longipedicellatum* De Wild., *S. dewildemanianum* Robyns and *S. keniense* Standl. are probably later synonyms of *S. runsoriense*.

Vouchers: U2: Mubuku Valley, Rwenzori, fl. July 1938, *Eggeling 3792*. U3: above bamboo zone Elgon, fl. Apr. 1930, *Liebenberg 1637*.

B. Subgenus **Brevantherum** (Seithe) D'Arcy in *Annals of Missouri Botanical Garden* 59: 267–274 (1972); D'Arcy: 713 (1983). Type species: *S. erianthum* D. Don.

Plants unarmed. Hairs branched or stellate. *Leaves* mostly entire or nearly so. *Anthers* stout, opening by large terminal pores and sometimes ultimately by longitudinal slits. *Ovary* glabrous to tomentose. *Fruit* rather small, 7–20 mm diam. The subgenus is represented in Uganda by one section: *Brevantherum*.

Section **Brevantherum** Seithe in *Botanische Jahrbücher* 81: 297 (1962). Type species: *S. erianthum* D. Don.

14. *Solanum mauritianum* Scop., *Deliciae florae et faunae insubricae* 3: 16 t. 8 (1788). Type: Scop.: t. 8 (1788) (fide Roe 1972).

For synonymy see Heine (1963).

Shrub or small tree 4–7 m high, unarmed, young stem densely covered with sessile stellate hairs, stem with axillary subactive buds bearing small leaves. *Leaves* elliptic-ovate, entire, up to 250 \times 100 mm, apices acute, bases attenuate; both surfaces of leaves densely covered with stellate hairs; petiole to 70 mm long. *Inflorescence* terminal, paniculate, many(> 50)-flowered. *Flowers* purple; pedicels \pm 5 mm long. *Corolla* 15 mm diam., lobes 5 mm long. *Anthers* differing slightly in length, i.e. 1 short (\pm 1.8 mm), 2 or 3 medium (2 mm) and 2 longest (2.4 mm). *Fruit* spherical, pubescent, green when young, yellow when mature, 12 \times 11 mm; stalk \pm 5 mm long. *Seeds* 2 \times 2 mm. 2n = 24 (D'Arcy 1974).

S. mauritianum is a widespread weed in Uganda and other parts of tropical Africa. The closely related species *S. erianthum* D. Don. and *S. umbellatum* Mill., established elsewhere in Africa (Bukenyi & Hall 1988), have not yet been recorded for Uganda.

S. mauritianum, *S. erianthum* and *S. umbellatum* are native to the Americas. Their spread to Africa has been associated with the 16th century Spanish and Portuguese trade routes (Roe 1979). These species are colonizers of open ground: forest openings, stream borders and areas of human disturbance such as roadsides.

Reproduction in these plants is not only by seed, but apparently more commonly by adventitious roots from shallow roots to form large colonies. They are self-compatible, another characteristic of successful weeds. The colourful berries and frequently isolated plants suggest bird dispersal of seed (Roe 1979).

S. mauritianum has been widely known in the past as *S. auriculatum* Aiton but the publication of *S. mauritianum* antedates this name by one year.

Voucher: U4: Nakiyaga Masaka, fl. & fr. Sept. 1989, *Bukenyi 49*.

C. Subgenus **Leptostemonum** (Dunal) Bitter in *Botanische Jahrbücher* 55: 69–89 (1919); D'Arcy: 684 (1973); Whalen: 179–282 (1984). Lectotype: *S. mammosum* L. (fide D'Arcy 1972).

Indumentum often stellate, prickles usually present. *Anthems* mostly slender, tapering to the tip and opening by small terminal pores or, if stout, narrowing abruptly to a small tip and also often opening by longitudinal slits near base, dehiscent introrsely or extrorsely by outward bending of the tips. *Ovary* glabrous. *Fruit* often large (7–)10–80(–90–130 mm).

This subgenus is the largest in Uganda, represented by six sections: *Leptostemonum* (*Acanthophora*), *Aculeigerum*, *Melongena*, *Monodolichopus*, *Oliganthes* and *Torva*.

Section *Acanthophora* *Dunal*, Histoire Naturelle, Médicale et Économique des *Solanum*: 131, 132 (1813); D'Arcy: 909 (1973). Type species: *S. mammosum* L. (fide D'Arcy 1972).

15. *Solanum mammosum* L., Species plantarum: 187 (1753); D'Arcy: 712 (1973); Nee: 576 (1979). Lectotype: Pluk.: t. 226, fig. I (1696). (Typotype: Herb. Sloane Vol. 98 fol. 59 (BM). For reasons for type selection see Jaeger (1985).

A list of synonyms is given by Whalen (1984).

Shrub about 1.5 m high. *Stems* densely covered with simple hairs ± 2 mm long, and slightly decurved prickles that are 5 mm long with base 2 mm broad. *Leaves* $\pm 110 \times 90$ mm, lobed or doubly lobed to about $\frac{1}{2}$ width of leaf; lobes triangular; prickles on midrib straight, ± 17 mm long, base ± 1 mm broad, on primary lateral veins 3–8 mm long, hairs on upper surface mainly simple, on lower surface stellate mixed with simple hairs; petiole up to 70 mm long with simple hairs and straight prickles ± 13 mm long, base 1 mm broad. *Inflorescence* 3–4-flowered; pedicel ± 7 mm long. *Corolla* violet or blue, ± 12 mm long. *Fruit* up to 50 mm wide, bearing a terminal nipple or mammilla, 5 mammillae or protuberances often present at base. *Seeds* brown. $2n = 22, 24$ (Heiser 1971).

S. mammosum is an introduced ornamental which is rarely found in Uganda, being native to the Caribbean region of central America where it is found in disturbed habitats and where it is cultivated for its curious fruits which are used as a medicine and as a cockroach poison (Duke 1970).

Vouchers: U3: Serere, Teso, fr. Dec. 1931, *Chandler* 203. U4: Makerere Univ., fl. & fr. Feb. 1992, *Bukenya* 143 (seed from Nakasero nr Kampala).

16. *Solanum aculeatissimum* Jacq., Icones plantarum rariorum 1: 5, t. 41 (1781); C.H. Wright: 228 (1906); Bitter: 148 (1923); Dalziel: 432 (1937); Heine: 535 (1963); Gbile: 115 (1979). Type: cultivated plant at Vienna, *Jacquin s.n.* (W).

For synonymy see Whalen (1984).

Shrub ± 1.5 m high, densely pubescent with simple hairs 0.1–1.0 mm long, decurved prickles up to 12 mm long with base 0.5 mm broad. *Leaves* $\pm 180 \times 160$ mm, lobed or doubly lobed to $\frac{1}{3}$ width of leaf, with 3–4 pairs of major triangular lobes; middle lobe up to 55 mm long;

simple pilose hairs on both surfaces or leaves, rare stellate hairs on underside; prickles on midrib and petiole slender, ± 15 mm long, base 0.8 mm broad, purple near base, upper part yellow; petiole 4–80 mm long. *Inflorescence* 3–6-flowered. *Corolla* white, $\pm 17 \times 30$ mm, peduncle 0.5 mm long; pedicel ± 11 mm long. *Fruit* globose, ± 35 mm diam. *Seeds* 3×4 mm, brownish.

S. aculeatissimum generally grows in forest clearings. It is widely distributed throughout Africa. It also occurs in southeastern Brazil (Whalen 1984). It is likely to have been introduced to Africa several hundred years ago (Jaeger 1985).

Vouchers: U1: Kidepo N.P., fl. & fr. Sept. 1972, *Synnott* 1269. U2: Kizimba Bundibugyo, fl. Sept. 1991, *Bukenya* 146. U4: Entebbe Region, Mar. 1921, *Kew Herb. sheet* No. 681.

Section *Aculeigerum* *Seithe* in Botanische Jahrbücher 81: 291, 292 (1962). Type species: *S. wendlandii* Hook.

17. *Solanum wendlandii* Hook. in Curtis's Botanical Magazine 113: t. 6914 (1887). Type: cultivated at Kew from Costa Rican seed (K!).

Woody climber, armed with small recurved prickles on stem and midribs of leaves. *Leaves* up to 150×120 mm, broadly elliptic, compound; at base, leaflets separate, towards apex lamina only deeply divided. *Inflorescence* many (50+)–flowered. *Inflorescence* axis very long, ± 300 mm. *Flowers* purple; pedicel 20 mm long. *Calyx* 3 mm long. *Corolla* 50 mm wide. *Stamens* of different filament lengths: 5 mm (1), 3 mm (2) and 2 mm (2); anther tips purple, lower part yellow. $2n = 24$ (Federov 1969; Whalen 1984).

S. wendlandii is widely cultivated in the tropics as an ornamental for its showy flowers. It flowers regularly but the senior author has never seen it fruiting. It is probably a native of Costa Rica (Whalen 1984).

Vouchers: U4: M1 2 Gayaza Rd, fl. Aug. 1990, *Bukenya* 53; Buganda Road P.S., fl. Apr. 1990, *Bukenya* 44; Masaka City, fl. May 1952, *Lye* 6840.

Section *Melongena* *Dunal*, Histoire Naturelle, Médicinale et Économique des *Solanum*: 208–218 (1813); D'Arcy: 698 (1972). Type species: *S. melongena* L. (fide D'Arcy 1972).

18. *Solanum melongena* L., Species plantarum: 186 (1753); Wright: 242 (1906); Bitter: 292 (1923); Heine: 322 (1963); D'Arcy: 704 (1973); Hepper: 122 (1976); Khan: 630 (1979). Type: lectotypified by D'Arcy (1974) with LINN 248.28 (IDC microf. 139: II.2).

A list of synonyms is given by Heine (1963) and Whalen (1984).

Shrub ± 1.5 m high. *Stem* with stellate hairs of 8–10 unequal arms. *Leaves* $\pm 150 \times 100$ mm, bearing on both surfaces short, stalked, stellate hairs, margin with 2–3 pairs of lobes up to 30 mm long; petiole about 40 mm

long. *Flowers* usually solitary or inflorescence 2–3-flowered; pedicel \pm 25 mm long. *Corolla* 20–22 mm long, purple, petal tips apiculate, incurved. *Calyx* about 10 mm long, normally not prickly but prickles 2–3 mm long may occur. *Fruit* ovoid or globose, 60–130 \times 30–100 mm, green, with white patches, white or purple when young, orange-yellow to brownish when ripe; fruit stalk 20–80 mm long, decurved. *Seeds* 3 \times 4 mm. $2n = 24$, but tetraploid forms occur (Whalen 1984).

S. melongena is an important commercial fruit/vegetable in Uganda. The species is believed to have originated in Asia (Indo-Burma) and is now cultivated on all continents for its edible fruits. *S. melongena* is believed to have evolved from *S. incanum sensu lato* which migrated into Asia from northeastern Africa and the Middle East (Lester & Hasan 1991).

Vouchers: U2: Kyembogo D.F.I., fl. & fr. Oct. 1990, *Bukenya* 108. U3: Kyabirwa, Budondo-Jinja, fl. Aug. 1991, *Bukenya* 130. U4: Bukanaga, Mityana, fl. & fr. Aug. 1990, *Bukenya* 71.

19. *Solanum aculeastrum* Dunal in A.P. de Candolle, *Prodromus systematis naturalis regni vegetabilis* 13,1: 366 (1852). Type: South Africa, Cape Province, Morley, Drège (Vb, as *S. sodomum*) (G-DC, IDC microf. 2091: III.4).

For synonymy see Heine (1963), Whalen (1984) and Jaeger (1985).

Shrub to small tree up to 7 m high. *Leaves* with deep lobes about 30 mm long, upper surface glabrous, lower with a heavy cushion of stellate hairs; petiole short, about 20 mm long. *Inflorescence* few- to 10-flowered, only 1 or 2 flowers functionally female. *Flowers* white, \pm 25 mm diam., lobes \pm 10 mm long; pedicel \pm 15 mm long. *Antthers* \pm of equal length. *Fruit* warted, yellow when ripe, 40 \times 42 mm; stalk slightly decurved, about 30 mm long. *Seeds* 4 \times 3 mm. $2n = 24$ (Whalen 1984).

S. aculeastrum is a native African species extending eastwards from Imatong Mts in Sudan to the Cape in South Africa and westwards from Cameroon highlands. It is rather variable. Jaeger (1985) divided it into 4 subspecies (subsp. 1; subsp. 2; subsp. *aculeastrum* and subsp. *thomsonii*). It has many traditional uses (Bukenya 1993).

Vouchers: U2: Mushunghero, Bufumbira, fl. & fr. 1970, *Katende* 153. U3: Buwenda-Busoga, fl. July 1945, *Wakabi* 41; Iganga Town, fl. & fr. Aug. 1991, *Bukenya* 135. U4: Wattuba nr Kiboga, fl. & fr. Aug. 1970, *Katende* 498.

20. *Solanum incanum* L., *Species plantarum*: 188 (1753); C.H. Wright: 238 (1906); Bitter: 200 (1923); Dalziel: 433 (1937); Heine: 332 (1963); Gbile: 118 (1979). All the above authors have taken *S. incanum* in a broad sense.

The typification of *S. incanum* L. is discussed in a paper by Hepper & Jaeger (1985), who selected a neotype (Herb. J. Burs. vol. 9 No. 20 UPS IDC microf. series No. 1064 51: 1.4).

An extensive list of synonyms is provided by Heine (1963), Whalen (1984) and Jaeger (1985).

Shrub 1.0–3.0 m high; stem with stellate floccose hairs with 8–10 more or less equal arms; prickles \pm 5 mm long with base \pm 2 mm broad. *Leaves* \pm 240 \times 120 mm; margin sinuate or with 3 pairs of short lobes; middle lobe up to 20 mm long; both surfaces with stellate hairs; prickles on midrib \pm 3 mm long with base \pm 0.5 mm broad; petiole up to 70 mm long. *Inflorescence* up to 10-flowered; 1–5 flowers functionally female; pedicel \pm 10 mm long. *Corolla* violet, \pm 30 \times 27 mm. *Calyx*, especially on the lowermost flower, very prickly, prickles \pm 2 mm long. *Fruits* globose, 30 \times \pm 27 mm, green with light green patches when young, yellow when ripe.

S. incanum sensu lato is extremely common in Uganda, occurring in all the geographical regions and different habitats. It is polymorphic, and its intraspecific variation requires a thorough study, especially experimental work.

Jaeger (1985) treated *S. incanum* in Africa as a species aggregate and divided it into five groups. These include *S. incanum* group which occurs in the dry country scrub of NE Africa and the middle East; *S. lichtensteinii* group which is found in wooded grasslands of southern Africa; *S. panduriforme* group which occurs in eastern southern Africa; *S. campylacanthum* group, a common shrub of disturbed ground in the grasslands of central, East and southern Africa and *S. cerasiferum* group which occurs in NE Africa extending to northern Nigeria. Lester & Hasan (1991) divided *S. incanum sensu lato* into four groups: Group A, including *S. lojeru* Dunal, *S. campylacanthum* Dunal, *S. delagoense* Dunal and many other species recognised by Bitter (1923); Group B containing *S. panduriforme* Dunal only and has the narrowest leaves of all the species; Group C being *S. incanum* L. *sensu stricto* (Hepper & Jaeger 1985); and Group D containing *S. lichtensteinii* Willd. and allied taxa.

The Ugandan material of *S. incanum sensu lato* possibly belongs to Jaeger's *S. panduriforme* group (Lester & Hasan's Group B and Jaeger's *S. campylacanthum* group (Lester & Hasan's Group A).

Vouchers: U1: Amolotar Lango, fl. Sept. 1946, *Dawkins* 218. U2: 5 km NE of Nyarushanje, fl. & fr. Dec. 1968, *Lye* 1082. U3: Serere, fl. Sept. 1970, *Edaru* 2. U4: Mulago, fl. Sept. 1967, *Mweheire* 20; Kasa Forest nr L. Wamala, fl. Nov. 1949, *Dawkins* 454.

21. *Solanum macrocarpon* L., *Mantissa altera*: 205 (1771); C.H. Wright: 214 (1906); Bitter: 195 (1923); Burkill: 333 (1925); Dalziel: 343 (1937); Heine: 234 (1963). Lectotype: Sheet 248.11 in LINN (IDC microf. 138: II.3). The selection of this lectotype is discussed by Jaeger (1985).

The synonymy is discussed by Burkill (1925), Heine (1963), Whalen (1984), Jaeger (1985) and Bukunya (1993).

Subshrub or shrub, 0.5–1.5 m high. *Stem* terete, glabrous or with stellate hairs; not prickly or with prickles \pm 6 mm long. *Leaves* 150–460 \times 80–300 mm, entire or with short lobes, \pm 10 mm long to deeply doubly lobed

with major lobes up to 80 mm long; young leaves bear on upper surface simple, or stellate hairs, either singly or in combination; lower surface with stalked stellate or more or less sessile stellate hairs; mature leaves glabrous or with simple hairs and stellate hairs; prickles present or absent on leaves, when present, principally on midrib and lateral veins; petiole very short to 70 mm long. *Inflorescence* lateral, racemose, 3–12-flowered. *Flowers*: lowermost flower or flowers hermaphrodite, larger than the rest and functionally female, distal flowers with short styles, functionally male. Normally 1–2(–5) hermaphrodite plus 1–4 functionally male flowers present. *Corolla* infundibuliform-rotate or campanulate, 20–35 mm long, white, light purplish or blue. *Calyx* not prickly or with prickles \pm 10 mm long; fruiting calyx often accrescent, 15–50 mm long. *Ovary* glabrous or with short-stalked or sessile glandular hairs. *Fruit* depressed globose, 20–60 \times 30–100 mm, green, ivory or purplish white with dark stripes; when ripe, yellow to brownish; stalk erect or decurved, 10–40 mm long. *Seeds* 3.0–4.5 \times 2.0–3.6 mm. $2n = 24$.

The *S. macrocarpon* complex is extremely variable. In this treatment the complex is taken as a combination of *S. macrocarpon* L. and *S. dasyphyllum* Schum. & Thonn. This is because Bukenya (1993) obtained fully fertile F1 and F2 hybrids (pollen stainability was 80–100%) between what was previously known as *S. macrocarpon* and *S. dasyphyllum*. All accessions of these taxa and of hybrids between them showed 12 bivalents at metaphase-I of meiosis and regular disjunction indicating that they belong to the same biological species. Bukenya (1993) split the complex in Uganda into four major groups: two are cultivars, one is a semi-wild and the fourth is the wild group (formerly called *S. dasyphyllum*).

Seme (1983), Bista (1983) and Jaeger (1985) were also of the opinion that the separation of *S. macrocarpon* and *S. dasyphyllum* is no longer justifiable. The *S. macrocarpon* complex is closely related to *S. sessilistellatum* Bitter which is endemic to Kenya, but distantly related to the *S. incanum* group (Whalen 1984).

The *S. macrocarpon* complex is native to Africa from where cultivars were introduced to other parts of the world. In Uganda, the complex, especially the wild group, is widely distributed.

S. macrocarpon (cultivated group)

Vouchers: U3: Nkoma Bujoloto, fl. Aug. 1991, *Bukenya* 138. U4: Nabingo, fl. & fr. Sept. 1990, *Bukenya* 80.

S. macrocarpon (semi-wild group)

Vouchers: U3: Budondo Jinja, fl. Aug. 1991, *Bukenya* 131. U4: Nabingo, fl. & fr. Oct. 1990, *Bukenya* 83.

S. macrocarpon (wild group)

Vouchers: U1: Napak Karamoja, fl. & fr. July 1948, *Philip* 203. U2: Mile 8 Kingumya Bwamba, fl. & fr. Sept. 1991, *Bukenya* 148. U4: Kivuvu-Mityana, fl. & fr. Aug. 1990, *Bukenya* 61, 62.

22. *Solanum wrightii* Benth. in *Flora hongkongensis*: 243 (1861); Bitter: 180 (1923); Heine: 248 (1960);

Irvine: 733 (1961); Heine: 335 (1963); Gbile: 119 (1979). Type: Hong Kong, *C. Wright* 489 (K!).

For synonyms see Heine (1960, 1963) and Jaeger (1985).

Small tree up to 10 m high. *Stem* bearing prickles, and stellate hairs on setae \pm 1 mm long. *Leaves* \pm 300 \times 240 mm, with 2–3 pairs of prominent lobes up to 90 mm long, upper surface bearing simple hairs \pm 1 mm long, lower surface with stellate hairs with 5–8 unequal arms on setae \pm 0.5 mm long; prickles on midrib 10–20 mm long, base 4 mm broad; petiole \pm 100 mm long; prickles on petiole up to 20 mm long with base 6 mm broad. *Inflorescence* > 20-flowered. *Corolla* blue to violet, turning white with age, up to 45 \times 80 mm. *Calyx* \pm 20 mm long; pedicel \pm 25 mm long. *Anthers* of different length (2 \pm 20 mm long, 2 medium, 1 short). *Fruit* globose, green when young with light green patches, yellow when ripe, 50 \times 55 mm; fruiting calyx about 20 mm long.

S. wrightii is an introduced decorative tree which is a native of Bolivia. It has been introduced to other tropical areas of the world.

Vouchers: U2: Kyembogo D.F.I., fl. & fr. Oct. 1990, *Bukenya* 107. U3: Jinja town, fl. Aug. 1991, *Bukenya* 125. U4: Mityana S.S., fl. & fr. Aug. 1990, *Bukenya* 69, 70.

Section *Monodolichopus* Bitter in Feddes Repertorium Beih. 16: 297–307 (1923). Type species: *S. coagulans* Forssk. [fide Seithe (1962) as *S. dubium* Fresen.].

23. *Solanum coagulans* Forssk. *Flora aegyptiaco-arabica* 108 and 47. Cent. 1155 (1775). Type: Yemen, *Forsskål s.n.* (C).

Perennial herb, often with several stems up to 0.7 m high. *Stems* with white stellate hairs, usually covered with dense straight yellow prickles. *Leaves* very variable, up to 100 \times 50 mm or more, ovate-lanceolate, prickly and hairy. *Inflorescence* racemose, with 6–10 flowers. *Corolla* blue-violet, 10–15 mm diam. *Stamens* unequal, one filament slightly longer than rest. *Fruit* yellow, globose, 10 mm diam., dry, usually completely enclosed by heavily armed accrescent calyx. *Seeds* shiny black.

Jaeger (1985) took a broad view of the species to include *S. dubium* Fresen., *S. thruppi* C.H. Wright, *S. depressum* Bitter and *S. ellenbeckii* Dammer. On the other hand Whalen (1984) used *S. thruppi* for *S. dubium* and commented that: 'S. dubium was published by Fresenius in 1834 but was pre-dated by *S. dubium* Dunal (1813) an unrelated species. A still earlier name is *S. coagulans* Forssk. (1775), but that epithet has been persistently misapplied and probably should be rejected'. This controversy needs to be resolved.

S. coagulans is not common in Uganda. It has been collected from Ankole and Karamoja. These are pastoral areas and the species is noted to withstand overgrazing pressures due to its heavy armature and creeping nature. On the African continent, it occurs from Egypt to Tan-

zania. It has no clear relatives among the Old World solanums (Whalen 1984).

Vouchers: U1: Kangole, Karamoja, fl. & fr. May 1940, *Thomas 3482*. U2: Mbarara, fl. & fr. 1925, *Maitland 1377*.

Section **Oliganthes** (*Dunal*) *Bitter* in Feddes Reperitorium Beih. 16: 1 (1923); D'Arcy: 272 (1972). Lectotype: *S. indicum* auct. non L. (= *S. anguivi* Lam.), fide D'Arcy (1972).

24. ***Solanum anguivi* Lam.** in Tableau Encyclopédique et Méthodique: 23 (1794); Hepper: 287–292 (1978). Type: Madagascar, *Commerson s.n.* Holotype: MPU, syntype P, fide Hepper (1978). According to D'Arcy & Rakotozafy (1994), Hepper (1978) has chosen a lectotype, and not indicated the holotype, because a specimen exists in P-JU which Lamarck is sure to have examined.

For synonymy see Whalen (1984) and Bukenya & Hall (1988).

Shrub 1.5–3.0 m high. *Stem* bearing small, sessile stellate hairs with $4-8 \pm$ equal arms; sometimes prickly. *Leaves* elliptic-ovate, $100-200 \times 50-100$ mm, sinuate to distinctly lobed, 2–4 pairs of lobes, lobes 20–30 mm long, apex acute to obtuse, base oblique, occasionally truncate or subcordate; both surfaces of leaves have \pm sessile stellate hairs with $6-10 \pm$ equal arms; petiole 20–60 mm long, with dense stellate hairs. *Inflorescence* a raceme-like cyme, 5 to > 15 -flowered, occasionally flowers solitary, extra-axillary, flowers mostly hermaphrodite, occasionally distal flowers with short styles, functionally male; peduncle 0–3–6 mm long; pedicel 4–15 mm long, bearing stellate hairs. *Corolla* $\pm 10 \times 10$ mm, white, occasionally with light purple veins on outer surface; with stellate hairs outside, \pm glabrous on inner surface. *Fruit* 7–18 \times 8–12 mm, mostly globose, smooth, green or white when young, red when ripe; stalk 8–15 mm long, usually erect, occasionally horizontal or decurved. *Seeds* $1.5-2.1 \times 1.9-2.9$ mm.

S. anguivi is a rather polymorphic species. It exhibits tremendous variation in features such as prickliness, pubescence and inflorescence. This variation is possibly partly due to domestication and partly to selection. There has been a shift from prickly, many-flowered and small-fruited types to prickless, less-flowered and large-fruited types (Bukenya 1980).

Bitter (1923) recognised more than 10 subspecies and several varieties for this species. Jaeger (1985) recognised five subspecies of *S. anguivi*. A revision of Bitter's infraspecific classification is necessary, following experimental work. Many of Bitter's infraspecific names are likely to be reduced to synonyms. No infraspecific combinations of Bitter's subspecific names have yet been published for *S. anguivi* (Jaeger 1985).

Lester & Niakan (1986) demonstrated that *S. anguivi* is most likely the wild progenitor of the red or orange-fruited garden eggplants (*S. aethiopicum*) commonly cultivated in Africa.

In Uganda *S. anguivi* is a minor crop, grown for its fruits. It also grows as a weed, possibly dispersed by birds. *S. anguivi* is widely distributed on the African continent and its neighbouring islands, e.g. Madagascar.

Vouchers: U1: Napak, Karamoja, fl. & fr. June 1950, *Eggeling 5956*. U2: Nyaruzinga Bushenyi, fl. & fr. Oct. 1990, *Bukenya 104*; Kalinzu Forest, fr. Mar. 1970, *Synnott 415*. U3: Budondo Jinja, fr. Aug. 1991, *Bukenya 126*. U4: Bukenaga Mityana, fl. & fr. Aug. 1990, *Bukenya 67*.

25. ***Solanum aethiopicum* L.**, *Amoenitates academicae*: 307 (1759); Dalziel: 432 (1937); Heine: 332 (1963); Gbile: 115 (1979). Lectotype: 'Habitat in Aethiopia', Burser vol. 9, No. 17 (IDC microf. 1064, 51: 2) selected by Hepper & Jaeger (1985).

Lester & Niakan's (1986) biosystematic studies showed that all the African taxa of *Solanum* section *Oliganthes* series *Aethiopica* recognised by Bitter (1923): *S. gilo* Raddi (including *S. olivare* Paill. & Bois); *S. zucagnianum* (= *S. aethiopicum* L. sensu Bitter); *S. aethiopicum* L. and *S. aethiopicum* var. *aculeatum* (= *S. integrifolium* auct. non Poir.), comprise a single species. They gave these four taxa non-Linnaean names under *S. aethiopicum* L. These are Gilo group, Shum group, Kumba group and Aculeatum group, respectively.

The Gilo group is cultivated in Africa for its fruits; Aculeatum group is grown in several European gardens, not African; Shum group is a leafy vegetable in tropical Africa, and Kumba group is cultivated for its large fruits and leaves, especially around the Niger River.

The Gilo and Shum groups occur in Uganda. Lester & Niakan's system (1986) is followed.

25a. *Solanum aethiopicum* Gilo group

For synonymy see Heine (1963), Whalen (1984) and Jaeger (1985).

Shrub 1–2 m high; stem bearing tiny sessile stellate hairs of $4-5 \pm$ equal arms. *Leaves* elliptic-ovate, $100-240 \times 70-180$ mm, margin sinuate-repand to distinctly lobed with 2–4 pairs of lobes up to 50 mm long, apex acute, base oblique; both surfaces but especially the lower, with \pm sessile stellate hairs with 7–9 unequal arms; petiole 15–18 mm long; prickles may occasionally be present on young leaves. *Flowers* usually solitary or two next to each other, rarely 3–5 or more arising from a common stalk, extra-axillary and hermaphrodite. *Corolla* $\pm 15 \times 20-30$ mm, white, occasionally light purple; petal tips apiculate, incurved; inner and outer surface of corolla with stellate hairs; pedicel ± 15 mm long. *Fruit* ellipsoid, globose or oval, $13-70 \times 15-50$ mm, smooth or with shallow longitudinal grooves, usually solitary, occasionally two or more together, green, white or purple when young, red when mature; fruit stalk 16–40 mm long, mostly decurved. *Seeds* 3×4 mm.

The Gilo group is by far the most widely grown cultivar group of *Solanum* species throughout southern Uganda. Its fruits are used in soup or stew preparation. It is preferred to *S. melongena* because it has softer flesh than *S. melongena*. Within the Gilo group there is considerable

variation, especially in the shape, size and colour of the fruit. This cultivar group is native to Africa and is believed to have arisen from the wild, weedy and semi-cultivated but poorly domesticated *S. anguivi* (Lester & Niakan 1986).

Vouchers: U2: Kyembogo D.F.I., fl. & fr. Oct. 1990, *Bukenya* 109. U3: Abwagati Tororo, fl. & fr. Aug. 1991, *Bukenya* 134. U4: nr Kisasa Bukoto, fl. May 1972; Kivuuvu Mityana, fl. & fr. Aug. 1990, *Bukenya* 58.

25b. *Solanum aethiopicum* Shum group

S. zuccagnianum Dunal (1813, 1852).

Subshrub about 0.6 m high; stem glabrous. *Leaves* ovate, about 150×100 mm, apex acute, base oblique, attenuate or truncate, margin repand; young leaves on both surfaces with small, sessile, stellate hairs with 5–8 more or less equal arms; mature leaves subglabrous; petiole 50–60 mm long. *Inflorescence* 3–10-flowered, sessile or flowers solitary, lateral; flowers hermaphrodite; pedicel ± 7 mm long with scattered stellate hairs. *Corolla* white, 5–7 mm long $\times \pm 10$ mm wide, glabrous; flower buds with dense stellate hairs. *Calyx* as long as the corolla tube. *Style* with stellate hairs. *Fruit* globose, 15–35 mm diam., green with dark green stripes when young, shiny red when ripe; fruiting calyx ± 7 mm long; stalk up to 12 mm long. *Seeds* 2.8×3.0 mm.

In Uganda the Shum group is a popular leaf vegetable in Buganda region, from where it has been introduced by migrants from Buganda to a few areas in western and eastern Uganda. It is native to Africa and is frequently cultivated in tropical Africa. It is less polymorphic than its relatives, the Gilo group and *S. anguivi*.

Vouchers: U2: Nyaruzinga, fr. Oct. 1990, *Bukenya* 106. U3: Budondo Jinja, fr. Aug. 1991, *Bukenya* 127. U4: 2 km E of Budo, fl. & fr. Nov. 1972, *Katende* 1727.

26. *Solanum albicaule* Kotschy ex Dunal in A.P. de Candolle, *Prodromus systematis naturalis regni vegetabilis* 13,1: 204 (1852); C.H. Wright: 255 (1906); Bitter: 101 (1923); Carvalho & Gillet: 237 (1960); Heine: 204 (1963). Type: Sudan, Kordofan, *Kotschy* 309 (G, holo.).

The species is sunk under *S. forskalii* Dunal by D'Arcy & Rakotozafy (1994).

For synonymy see Heine (1963).

An undershrub about 1 m high. *Branches* slender, shortly hairy-tomentose; hairs stellate. *Leaves* rather small, ovate, $20\text{--}70 \times \pm 10$ mm, subentire, covered with sessile stellate hairs on both surfaces. *Inflorescence* 3–6-flowered. *Flowers* bluish purple. *Calyx* about 3 mm long. *Corolla* 8–13 mm long. *Fruit* green with white stripes when young, yellow when ripe, up to 10 mm diam.

S. albicaule has been collected from the dry region of Karamoja. It extends into NE Africa (Sudan, Somalia, Eritrea and Egypt) and west and NW Africa (Senegal, Chad, Mauritania). Elsewhere, it has been recorded for

Arabia, Pakistan and India. It seems to be a species of arid lands. It has no close relatives in section *Oliganthes*.

Vouchers: U1: 5–6 km N of Lothea Bokora Karamoja, fl. May 1970, *Lye* 5455; 5 km S of Kantaku Bokora Karamoja, fl. & fr. June 1970, *Katende* 442.

27. *Solanum cyaneo-purpureum* De Wild., *Plantae bequaertianae* 1: 425 (1922). Type: Zaïre, Kabare, *Bequaert* 5333 (BR).

For synonymy see Whalen (1984) and Jaeger (1985).

Clambering shrub 2–3 m high; young stems, leaves on both surfaces with stalked stellate hairs; stem, petiole and midrib armed with short recurved prickles. *Leaves* ovate, $30\text{--}80 \times 20\text{--}40$ mm, entire or sinuate; petiole 5–20 mm long. *Inflorescence* 3–10-flowered, racemose. *Corolla* purple, up to 10×180 mm; pedicel up to 10 mm long. *Fruit* red when mature, ± 10 mm diam.; fruit stalk 10–20 mm long.

S. cyaneo-purpureum is common in the shrub forests in the plains of southwestern Uganda. It also occurs in Rwanda, Burundi and eastern Zaïre and often grows on termite mounds. It is related to *S. taitense* Vatke and *S. hastifolium* Hochst.

Vouchers: U2: nr Gayaza Rwampara Ankole, fl. & fr. Oct. 1932, *Eggeling* 661. U4: 17–18 km SE of Ntusi Mawogola, fl. & fr. Oct. 1969, *Lye* 4479.

28. *Solanum hastifolium* Hochst. ex Dunal in A.P. de Candolle, *Prodromus systematis naturalis regni vegetabilis* 13,1: 284 (1852). Type: Sudan, Kordofan, *Kotschy* 393 (MPU, holo.; K!, iso.).

For synonymy see Whalen (1984).

Shrub, often scandent, up to 2 m high; branches, petiole and midrib armed with small recurved prickles; stems and both surfaces of leaves covered with stalked stellate hairs. *Leaves* ovate, entire or sinuate, base shortly cuneate, about $50\text{--}70 \times 20\text{--}30$ mm. *Inflorescence* 2–6(–10)-flowered, umbelliform. *Corolla* violet, up to 10×15 mm. *Fruit* red when mature, ± 10 mm diam.

S. hastifolium is a deciduous bushland species of NE Africa, from northern Tanzania through Kenya and eastern Uganda to Sudan, Ethiopia and Somalia. It is rather polymorphic and often confused with *S. taitense* Vatke. It is also related to *S. cyaneo-purpureum* De Wild.

Vouchers: U1: nr Rupa, Karamoja, fl. & fr. Sept. 1958, *Wilson* 585. U4: Katuugo Buruli, fl. & fr. Oct. 1970, *Katende* 716.

29. *Solanum taitense* Vatke in Linnaea 43: 327 (1882). Type: Kenya, between Ndi and the river Tsavo, *Hildebrandt* 2605 (B⁺; isotypes possibly at L, M, P).

Slender-stemmed scandent shrub to 2 m tall; stem, petiole and midrib armed with small recurved prickles. *Leaves* lanceolate, entire, repand or lobed, $40\text{--}80 \times 20\text{--}40$ mm, on both surfaces with stalked stellate hairs. *Inflorescence* (1)2–4-flowered. *Corolla* pinkish purple, 8–15 \times

15–20 mm. *Fruit* green with white stripes when young, red when mature, ± 10 mm diam.

S. taitense is closely related to *S. hastifolium* and the two are often confused with each other. The former has a simpler inflorescence than the latter and leaf shapes are different in the two species. *S. taitense* is found in bushlands of Masaka, Ankole and Karamoja. It also occurs in Kenya and Tanzania.

Vouchers: U1: 5 km of Kantaku Bokora Karamoja, fl. & fr. June 1970, *Katende* 436. U4: 1–2 km E of Kikoma Mawogola, fl. & fr. Oct. 1969, *Lye* 4435.

30. *Solanum usambarense* Bitter & Dammer in Bitter, Feddes Repertorium Beih. 16: 40 (1923). Syn-types: *Holst* 380, 8921, 8925a (K!), 9091a; *Eick* 28a, 200, 273, 382; *Volkens* 616; *Buchwald* 380. All collected in northern Tanzania and all cited with original description.

Shrub up to 3 m tall, armed heavily with prickles, indumentum pilose. *Leaves* ovate, up to 200×150 mm, margin lobed, base truncate and unequal and may be shortly attenuate, covered with stellate hairs. *Inflorescence* 8- to many-flowered rachis simple or branched, racemose. *Corolla* creamy white with a purple tinge on the veins, ± 10 mm diam. *Fruit* orange-red or red, ± 8 mm diam.

S. usambarense has often been confused with *S. anguivi* (*S. indicum*). Although the two are closely related, *S. usambarense* is easily distinguished from *S. anguivi* by inflorescence and infructescence characters.

S. usambarense occurs in the shrub layer of the forests on mountains of Rwenzori, Elgon and Kigezi. It also occurs in the mountains of Kenya and Tanzania.

Vouchers: U2: Virunga-Kette Nkanda, fl. & fr. Nov. 1954, *Stauffer* 899. U3: Buhekeke Bugishu, fl. & fr. July 1926, *Maitland* 1213 (sheet 2).

Section **Torva** Nees in Transactions of the Linnean Society: 51 (1837); D'Arcy: 273 (1972). Type species: *S. torvum* Sw.

31. *Solanum giganteum* Jacq., Collectanea 4: 125 (1790); Jacq.: 11, t. 382 (1792). Type: collected near the Cape of Good Hope and cultivated in Vienna; in the absence of a specimen, the illustration t. 328 (fide Jaeger 1985) is taken as the type.

Shrub or tree up to 8 m high; stem and young leaves covered with white indumentum of tiny sessile stellate hairs; mature leaves with sessile stellate hairs on the undersurface, upper surface almost glabrous apart from occasional sessile stellate hairs; stem and petioles with flat triangular prickles. *Leaves* ovate to elliptic, up to 280×120 mm. *Inflorescence* paniculate, terminal or subterminal, 20 to > 60 -flowered. *Flowers* violet to purple, 8–10 mm long. *Fruit* green when young, red when ripe, globose, ± 10 mm diam.

S. giganteum is fairly common in Uganda. It is a distinct montane species stretching southwards from Ethiopia

to South Africa, and west to Cameroon. It has also been recorded in S India and Sri Lanka.

Vouchers: U2: Budongo, fl. & fr. Nov. 1932, *Harris* 161. U3: Mt Elgon, fl. Apr. 1930, *Lubenberg* 1664. U4: Entebbe, fl. & fr. Sept. 1922, *Maitland* 217.

32. *Solanum kagehense* group

This group was brought together by Jaeger (1985) for the convenience of dealing with material belonging to four closely related species: *S. kagehense* Dammer: 187 (1906). Type: Tanzania, Muansa, *Fischer* 78 (isotype LE?); *S. muansense* Dammer: 243 (1912). Type: Tanzania, Muansa, *Stuhlmann* 4504 (iso. HBG?); *S. sordidescens* Bitter: 260 (1921). Type: Mozambique, Tschumo, in Matumbi Mts, *Busse* iii 3097 (iso. E.A.); *S. wittei* Robyns: 82 (1943). Type: Zaïre, Kabasha, *De Witte* 1142 (holo. BR?).

Jaeger (1985) did not make new combinations since his grouping was based on published descriptions. He suggested that a study of the types should be undertaken before new combinations are made. His approach was adopted in this study.

Shrubs up to 3 m high. *Stem* with broad-based prickles and scattered sessile stellate hairs with \pm equal arms. *Leaves* elliptic, entire or repand, up to 150×70 mm; upper surface with sparse sessile stellate hairs about 6-armed, middle arm much longer than rest, lower surface with sparse or heavy cushion of same type of hairs as on upper surface. *Inflorescence* cymose with flowers often subumbellate on branched peduncle, 10–20-flowered. *Corolla* violet, $7\text{--}10 \times 14$ mm. *Fruit* red when ripe, ± 7 mm diam.

S. kagehense group occurs in all the geographical regions of Uganda. It is common in the East African region as a whole, especially in thickets and areas of light shade between 600–1 500 m. It is related to *S. renschii* Vatke. Some past plant collectors have confused it with *S. giganteum*.

Vouchers: U1: Kaabong Karamoja, Sept. 1950, *Dawkins* 643. U2: Ruizi R., Nov. 1950, *Jarrett* 208. U3: Serere Labori, July 1926, *Maitland* 1349; Busoga, June 1925, *Maitland* s.n.. U4: 5 km S of Sembabule, fr. May 1971, *Katende* 881.

33. *Solanum renschii* Vatke in Linnaea 43: 328 (1882). Type: Kenya, Ukamba, *Hildebrandt* 2735 (K!, iso.).

For synonymy see Whalen (1984) and Jaeger (1985).

Shrub or subshrub. *Stem* covered when young with small sessile stellate hairs with about $8 \pm$ equal arms; stem and petiole bear broad-based prickles; veins with tiny prickles. *Leaves* $50\text{--}80 \times 30\text{--}40$ mm, ovate, entire; upper surface covered with same type of hairs as above; lower surface covered with a heavy cushion of sessile stellate hairs, larger than above and with more than $10 \pm$ equal arms. *Inflorescence* corymbose, 20–50-flowered. *Corolla* pale violet, $\pm 10 \times 13$ mm. *Fruit* ± 8 mm diam., red/black when ripe.

S. renschii is endemic to eastern Africa, and is a variable species. Jaeger (1985) suggested that *S. kwebense* N.E. Br., *S. munitum* Bitter, *S. tettense* Klotzsch and the material in his *S. kagehense* group could be incorporated in a broad concept of the species. Whalen (1984) lists *S. tettense* and *S. wittei* A. Robyns as synonyms of *S. renschii*. *S. wittei* was included in Jaeger's *S. kagehense* group. If *S. tettense* and *S. renschii* are synonymous, then *S. renschii* should be sunk under *S. tettense*, having been published 21 years later than *S. tettense*. In Uganda *S. renschii* is restricted to the arid region of Karamoja.

Vouchers: U1: Moroto Karamoja, fl. & fr. Sept. 1956, *Bally* 10788; foothills of Mt Moroto, fl. & fr. Oct. 1952, *Verdcourt* 809.

D. Subgenus **Potatoo** (*G. Don*) D'Arcy, in *Annals of the Missouri Botanical Garden* 59: 272 (1972); D'Arcy: 750 (1973). Type species: *S. tuberosum* L.

Herbs, rarely woody, often glandular-pubescent and aromatic, unarmed; hairs simple. *Leaves* mostly compound or deeply lobed, but simple, entire leaves often present at certain stage. *Inflorescence* mostly panicle; peduncles once or ternately branched, often pendulous; pedicels mostly articulating near base or above it. *Fruit* 10–20 mm diam.

The subgenus is represented in Uganda by two sections: *Petota* and *Jaminosolanum*.

Section **Petota** *Dumort.* *Florula belgica*: 39 (1827). Type species: *S. tuberosum* L.

34. ***Solanum tuberosum* L.**, *Species plantarum*: 185 (1753); D'Arcy: 752 (1973). Lectotype: LINN 248.12 labelled 'S. tuberosum' (fide Hawkes 1956) (LINN IDC microf. 138: II.4).

Herb ± 1 m high; stem with shallow grooves when dry, and simple hairs; stolons tuberiferous. *Leaves* compound, interceptedly imparipinnate; major leaflets 3–7, alternating with ± 3 pairs of minor leaflets; leaflets elliptic to oblong-elliptic, $\pm 50 \times 25$ mm; simple hairs on both surfaces; petiole up to 60 mm long. *Inflorescence* panicle, 10–30-flowered, terminal on long peduncle ± 80 mm long; pedicel 7–15 mm long with simple hairs. *Flowers* hermaphrodite. *Corolla* white, bluish purple or purplish red, 10–22 \times ± 20 –30 mm. *Anthers* 5, occasionally 6. *Calyx* ± 7 mm long, with simple hairs on outer surface, glabrous within. *Fruits* globose, ± 7 mm diam. $2n = 48$.

S. tuberosum, is a mainly temperate crop introduced in East Africa about 100 years ago by missionaries from Europe. The main area of commercial cultivation of potatoes in Uganda is Kigezi, a mountainous area with cool climate. Potato growing has spread to other highland areas in the country. Lowland areas also in recent years have started growing especially lowland cultivars. Potato blight seems to be a more serious limiting factor to cultivation of potatoes than climate.

Vouchers: U2: Kacwekano D.F.I., fl. Oct. 1990, *Bukenya* 99–101. U4: Kamenyamigo D.F.I., fl. Oct. 1990, *Bukenya* 93; Makerere Univ., fl. Oct. 1990, *Bukenya* 92.

Section **Jaminosolanum** *Bitter ex Seithe* in *Botanische Jahrbücher* 81: 191 (1962); D'Arcy: 757 (1973). Type species: *S. jasminoides* Paxton.

35. ***Solanum seaforthianum* Andrews**, *The Botanist's Repository*: pl. 504 (1808). Lectotype: the plate cited (fide Symon 1981).

Woody climber; stem terete, glabrous apart from occasional tiny simple hairs. *Leaves* compound, imparipinnate to deeply pinnatifid with about 7–9 leaflets or lobes; leaflets up to 50×30 mm, elliptic; lower leaflets with \pm winged petiolule up to 5 mm long; upper leaflets (i.e. lobes) webbed together; lamina glabrous; margin ciliolate with sparse simple hairs; petiole up to 50 mm long. *Inflorescence* glabrous, mostly terminal or lateral, panicle with up to 30 flowers or more; pedicel up to 7 mm long. *Flowers* hermaphrodite. *Corolla* blue to violet, up to 15×20 mm. *Fruit* spherical, ± 10 mm diam., red when mature; up to 40 from an inflorescence; fruit stalk 10–14 mm long. *Seeds* 2×2 mm.

S. seaforthianum is an introduced decorative climber seemingly naturalized. It is native to central America and the West Indies, but has spread to many parts of tropical Africa, where it has been introduced for decorative purposes.

Vouchers: U1: Mulago hospital, fl. & fr. Apr. 1990, *Bukenya* 45; fl. & fr. Aug. 1990, *Bukenya* 55; Makerere Univ., fl. & fr. Apr. 1990, *Bukenya* 48.

CONCLUSIONS

Solanum americanum, *S. tanderemotum*, *S. incanum*, *S. macrocarpon* (wild group), *S. anguivi* and *S. kagehense* group are the most widespread taxa in Uganda, occurring in all four geographical regions of the country. On the other hand, *S. scabrum*, *S. terminale* subsp. *inconstans*, *S. benderianum*, *S. albicaule*, *S. renschii* and *S. seaforthianum* are the least widespread, occurring in only one region. The rest of the taxa are either fairly well distributed (occurring in three regions) or relatively rare (occurring in two regions). This is associated with habitat preference and/or utilization.

There is tremendous morphological variation within the *S. macrocarpon* complex. *Bukenya* (1993) recognised four groups belonging to the *S. macrocarpon* complex in Uganda. These include *S. macrocarpon* (wild group—*S. dasyphyllum*); *S. macrocarpon* (semi-wild group), *S. macrocarpon* 'Mukono' cultivar and *S. macrocarpon* 'Nabingo' cultivar. Sections *Solanum* and *Oliganthes* are also very variable. Experimental work on these taxa is still necessary to resolve their taxonomy.

At least 25 species in Uganda are useful or economically relevant. Pharmacological studies are needed to authenticate the medicinal potency of the various species used in traditional medicine. More attention should be paid to crops in terms of research to control pests and diseases, to increase yield and to produce well-adapted cultivars.

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A new species and a change of status in *Ophioglossum* (Ophioglossaceae: Pteridophyta) in Africa

J.E. BURROWS* and T.J. EDWARDS**

Keywords: Africa, new species, *Ophioglossum*, Pteridophyta

ABSTRACT

A new species, *Ophioglossum gracile* Pocock ex J.E. Burrows, is described from South Africa. A lectotype is chosen for *O. vulgatum* var. *kilimandscharicum* Hieron. and its status upgraded to a subspecies.

UITTREKSEL

Ophioglossum gracile Pocock ex J.E. Burrows, 'n nuwe spesie uit Suid-Afrika word beskryf. 'n Lektotipe word vir *O. vulgatum* var. *kilimandscharicum* Hieron. gekies en die status word opgegradeer tot 'n subspesie.

The species concept in *Ophioglossum* L. is greatly misunderstood and the species are consequently poorly delimited, largely because of the simple morphology of the genus and the resulting lack of characters upon which to base species. Recent research by the senior author (Burrows 1992) has resulted in a better understanding of the African taxa, largely due to extensive SEM studies of the spores. Consequently it has become necessary to describe and clarify the two following taxa.

1. *Ophioglossum gracile* Pocock ex J.E. Burrows, sp. nov. ab *O. vulgato* subsp. *africanum* trophophoris minoribus (longitudine plerumque < 33 mm) anguste ellipticis vel lanceolatis, sporisque muris secundariis tenuibus in quoque lumen descendentibus differt.

TYPE.—Western Cape, 3318 (Cape Town): Table Mountain, Woodhead Reservoir, (–CD), 30-6-1947, *Esterluyzen 13915* (BOL, holo.!: GRA!, NBG!, PRE!).

O. vulgatum L. var. *gracile* Pocock, ined.

O. nudicaule L.f., sensu Roux: 9 (1979).

Rhizome linear, 13–22 × 2–3 mm. **Roots** horizontal, fleshy, proliferous. **Leaves** one or two. **Stipe** (14–)21–48(–83) mm long, 50–70% of its length subterranean, stipe:trophophore length ratio 0.8–1.7:1, old stipe bases not persistent. **Trophophore** variable in shape, narrowly elliptic to lanceolate, (17–)26–32(–43) × (4–)7–9(–13) mm, length:width ratio 2.3–7.5:1, apex acute, apiculate, base narrowly cuneate to attenuate, trophophore held at 50°–60° from the horizontal, margins flat. **Venation** with secondary veins and blind veinlets laterally and distally but sparse or lacking proximally, epidermal cells elongate throughout with wavy to sinuous anticlinal cell walls,

stomata aligned. **Sporophore** (46–)76–108(–145) mm long, with (13–)18–22(–28) pairs of sporangia, sporophore:trophophore length ratio 2.0–5.3:1. **Spores** 40–47 µm in equatorial diameter, trilete; muri continuous, somewhat uneven, with thin, secondary muri descending into each lumen; lumina conical, minutely granular. Figures 1C & D: 2A.

Specimens examined

WESTERN CAPE.—3218 (Clanwilliam): Clanwilliam Dist., Boskloof, (–BB), 20-1-1947, *Schelte 1982* (BOL, K); Piquetberg Mtn, between Mounon's Vlei and Gruys Kop, (–DA), 7-11-1934, *Pillans 7257* (BOL), 3219 (Wuppertal): Cedarberg, Langberg, (–AC), 15-12-1941, *Esterluyzen 7334* (BOL); 16-12-1941, *Compton 12764* (NBG), 3318 (Cape Town): Table Mtn, near 'Slaangully', (–CD), 4-1908, *Dimmer 1297* (NBG, SAM); Wood Ravine and Slangolie, pipe track, at the spring, (–CD), 8-1907, collector unknown ex *Herb. Marloth 3778* (PRE); Table Mtn, lower reservoir, (–CD), 19-5-1956, *Esterluyzen 25846* (BM, BOL); Table Mtn, *Carmichael s.n.* (K), 3322 (Oudtshoorn): S slopes of Outeniqua Mountains, next to Montagu Pass, (–CD), 750m, 3-11-1983, *Vlok 748* (BOL); next to Outeniqua Pass, (–CD), 7-2-1985, *Vlok 923* (PRE).

Historically this taxon has caused much confusion and has been given several names: *O. nudicaule* (Roux 1979), *O. lancifolium* (Schelte & Anthony 1986) and *O. vulgatum* var. *ambiguum* (Pocock herb. annotation). Pocock named the taxon *O. vulgatum* L. var. *gracile* in an unpublished manuscript on southern African *Ophioglossum*. However, she confused the issue by including within the species collections which are now known to belong to *O. lusoafricanum* (Figure 2B) and *O. vulgatum* subsp. *africanum* (Figure 2D). While *O. gracile* appears to be most closely related to *O. vulgatum* subsp. *africanum*, it differs in its much smaller and narrower trophophores, and spores that consistently display primary muri that are interconnected by smaller and narrower secondary muri (Figure 2A), a character only seen elsewhere in the unrelated Namibian taxon currently included under *O. polyphyllum*. Its restriction to the winter rainfall area of the Cape separates it geographically from the summer

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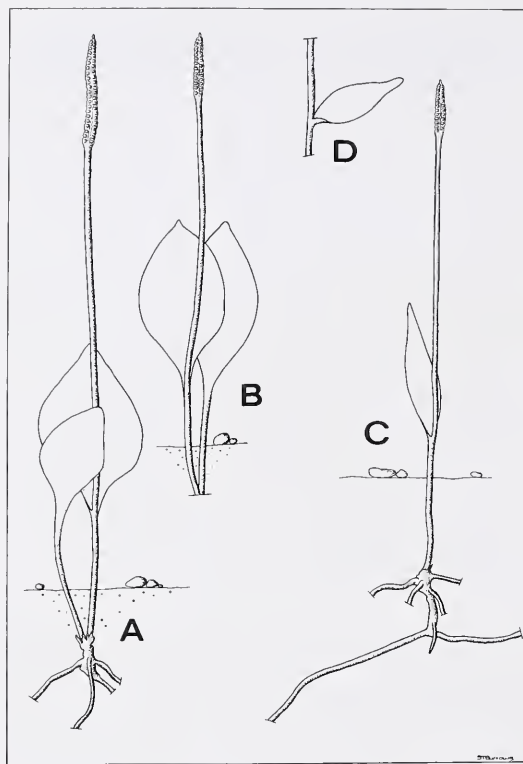


FIGURE 1.—*Ophioglossum vulgatum* subsp. *kilimandscharicum*: A, Schelpe 7177, whole plant; B, Schlieben 4987, trophophores. *O. gracile*, Esterhuysen 25846: C, whole plant; D, trophophore shape variant. All $\times 0.5$.

rainfall *O. vulgatum* subsp. *africanum*, and Pocock's species should therefore be awarded specific rank.

Within the circumscription of her original taxon, Pocock included two collections from the same locality near Grahamstown in the eastern Cape which most resemble *O. vulgatum* subsp. *africanum*. However, since I (senior author) have not examined the spores from this population, I cannot be certain of its identity. From the collection data, it seems that *O. gracile* is restricted to sandstones of the Table Mountain Series in ericoid scrub (fynbos) on moist soils. A collection from the Cedarberg (Esterhuysen 7334) was made on a 'damp spot at the base of a shale band'. The type collection was made on 'shallow soil on the banks of a small stream in shade of pines'. Collections have been recorded in January, February, April, May, June, August, November and December, indicating that this species may be evergreen in suitably moist situations. Its distribution falls within the winter rainfall area which receives most of its rain from May to September.

Although *O. gracile* shares the same phytogeological association as *O. bergianum*, there is no record of the two species growing in mixed communities. The third *Ophioglossum* species of the winter rainfall area of the Cape, *O. nudicaule*, is confined to shale-derived soils and does not occur with *O. gracile*.

Key to *O. gracile* and two similar species

- 1a Trophophore lanceolate to ovate; trophophore length:width ratio $< 3.3:1$;
- 2a Trophophores narrowly ovate to lanceolate, trophophore length:width ratio $1.8-3.5:1$; spores uniformly and smoothly reticulate *O. vulgatum* subsp. *africanum* Pocock ex J.E. Burrows
- 2b Trophophores ovate, trophophore length:width ratio $< 1.8:1$; spores with muri coalescing irregularly to form flattened areas *O. vulgatum* subsp. *kilimandscharicum* (Hieron.) J.E. Burrows
- 1b Trophophore elliptic, rarely lanceolate; trophophore length:width ratio $2.3-8.8:1$;
- 3a Trophophore elliptic or lanceolate; spores trilete, with secondary muri descending into the lumina *O. gracile* Pocock ex J.E. Burrows
- 3b Trophophore elliptic, rarely oblanceolate (never lanceolate); spores commonly alete, occasionally trilete, without secondary muri *O. lusoaficanum* Welw. ex Prantl

2. *Ophioglossum vulgatum* L. subsp. *kilimandscharicum* (Hieron.) J.E. Burrows, stat. nov.

Ophioglossum vulgatum L. var. *kilimandscharicum* Hieron. in Engler: 89 (1895). Type: Tanzania, Kilimanjaro, Kifinika Volcano, 2 800 m, Oct. 1893, Volken 1161 (B [destroyed]; BM!, lecto., here designated).

Differs from *O. vulgatum* subsp. *vulgatum* and *O. vulgatum* subsp. *africanum* (Pocock) J.E. Burrows by its more broadly ovate to elliptic trophophores with a length:width ratio of $1.8:1$, and the spores in which the muri coalesce irregularly into broad, flattened areas. Figures 1A & B; 2C.

Although Hieronymus designated no type specimen for his taxon (Engler 1895), all his new fern taxa from that expedition appear to have been collected by Volken in 1893. Engler also visited Kilimanjaro in the previous year

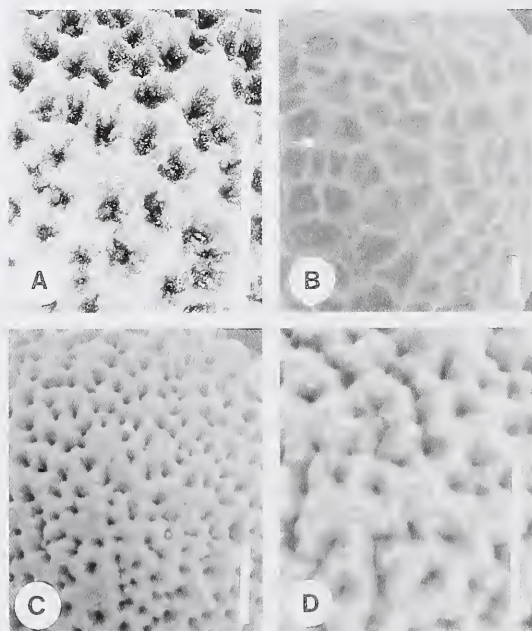


FIGURE 2.—Spores of *Ophioglossum*, distal face. A, *O. gracile*, Vlok 748; B, *O. lusoaficanum*, Burrows 5231; C, *O. vulgatum* subsp. *kilimandscharicum*, Lebrun 6016; D, *O. vulgatum* subsp. *africanum*, Chase 3758. Scale bar: 5 μ m.

(Gillett 1962) but since Engler mentions Volkens' collecting locality (Kifinika Volcano) in a subsequent account of the East African *Ophioglossum* (Engler 1908), it is likely that Volkens is the original collector of this taxon. A search for the type material in Berlin revealed that all pre-World War II material of *Ophioglossum* was destroyed (R.J. Johns pers. comm.). We can therefore assume that, if the specimen from which Hieronymus described the variety was in Berlin, it no longer exists.

There is, however, a collection made by Volkens on that expedition from the Kifinika Volcano, Kilimanjaro in the British Museum which is almost certainly isotypic. On the assumption that the Berlin material was destroyed and since no type was designated by Hieronymus, the sheet of *Volkens 1161* in BM is designated as the lectotype.

Hieronymus distinguished his variety on the basis of the plants having 'leaves nearly always in pairs, the sterile lamina obovate or elliptic (max. 30 × 17 mm), obtuse or slightly acute, spores 36–44 µm broad, areolae 2–4 µm wide'. The six collections seen that match the type specimen, differ from typical *O. vulgatum*. However, occasional trophophores within variable populations of normal *O. vulgatum* match subsp. *kilimandscharicum* quite well. Conversely, no trophophores on the collections of subsp. *kilimandscharicum* resemble those of typical *O. vulgatum*.

In addition, spores from the Natal and Transvaal collections reveal a morphological pattern distinct from both typical *O. vulgatum* and subsp. *africanum* (Figure 2D). The spore muri frequently coalesce into large flattened areas and the lumina are correspondingly smaller and more widely separated. A specimen from Zaïre (*Lebrun 6016*, Figure 2C) displays similar spore sculpturing and trophophores which match the Volkens collection. If these three collections belong to the Kilimanjaro taxon, then the spore pattern is distinct and constant. The trophophores are also subtly different from the typical plants in that they are broader, have a rounder apex and a thinner texture.

Very little is known of the ecology of this subspecies. The Kilimanjaro specimens were both collected at 2 800

m but no ecological data were given. The Drakensberg collection was made in burnt marsh under *Miscanthus* (Poaceae). The Transvaal collection was made at 1 645 m in submontane grassland, growing under *Helichrysum* (Asteraceae) bushes. As the subspecies is presently known, it is an afro-montane taxon and could be expected from the Zimbabwe/Malawi gap which currently exists.

Specimens examined

KENYA.—0035: Kericho Dist., western Mau Forest to Mt Blacket, Kipkuny R., (–BA), 13–6–1972, *Faden, Faden & Grumbley 72/358* (K).

ZAÏRE.—0226: between Kinolu and (KatoKikombe?), Maniema, (–AA), 8–1932, *Lebrun 6016* (BR).

TANZANIA.—0337: Kilimanjaro, Bergwiesen, (–A?), 24–3–1934, *Schlieben 4987* [B? (K, photo.), BM, BR, PRE].

SOUTH AFRICA (EASTERN TRANSVAAL).—2530 (Lydenburg): Lydenburg Dist., Buffelskloof Nature Reserve, below Stone Huts, (–BC), 8–1–1991, *Burrows 5133* (Herb. J.E.B., K, MICH, NU, PRE, TI).

SOUTH AFRICA (KWAZULU-NATAL).—2829 (Harrismith): Cathedral Peak area, Mhlonho Valley, (–CC), 1–1–1965, *Schelpé 7177* (BOL, NU).

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The generic delimitation of *Lachnaea* and *Cryptadenia* (Thymelaeaceae)

J.B.P. BEYERS* and J.J.A. VAN DER WALT**

Keywords: *Cryptadenia*, generic delimitation, *Lachnaea*, Thymelaeaceae

ABSTRACT

The current generic delimitation of *Lachnaea* L. and *Cryptadenia* Meisn. was investigated. A multidisciplinary approach was followed. This included a study of the habit, phyllotaxis, morphology and anatomy of the leaves and flowers, pollen morphology and karyology.

No major differences were found between the two genera. The range of variation of certain diagnostic characters of these genera is such that the genera merge into each other. It was concluded that the two genera are congeneric and the inclusion of *Cryptadenia* within *Lachnaea* is proposed.

UITTREKSEL

Die huidige generiese afbakening van *Lachnaea* L. en *Cryptadenia* Meisn. is ondersoek. 'n Multidissiplinêre benadering is gevolg. Die groeiwyse, blaarstand, morfologie en anatomie van die loofblare en blomme, stuifmeelmorfologie en kariolegie is bestudeer.

Geen noemenswaardige verskille tussen die twee genera is gevind nie. Die variasiegradiënt van sekere diagnostiese kenmerke van hierdie genera is van so 'n aard dat die twee genera oorvleuel. Die insluiting van *Cryptadenia* binne die omskrywing van die generiese grense van *Lachnaea* word voorgestel.

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INTRODUCTION

The genera *Lachnaea* L. and *Cryptadenia* Meisn. belong to the family Thymelaeaceae. Their close affinity is reflected by their placement in the different classification systems of the Thymelaeaceae (Endlicher 1847, sec. Domke 1934; Meisner 1857; Bentham & Hooker 1880; Gilg 1894 and Domke 1934). Only Baillon (1880) did not recognize *Cryptadenia* as a separate genus but treated it as a section of *Lachnaea*. He found that the flowers of *Lachnaea* varied from regular to irregular and that intermediate forms made it impossible to split the genus.

The genus *Lachnaea*, based on two species, was established by Linnaeus in 1753. In subsequent publications, such as Lamarck (1792, 1804), Salisbury (1808) and Sims (1813, 1814), new species were described, but only in 1840 was a detailed taxonomic account of the genus published by Meisner based on Drège's collections. Three sections were established, namely *Sphaeroclinium* Meisn., *Conoclinium* Meisn. and *Microclinium* Meisn., based on the inflorescence structure. Thirteen species and six infraspecific taxa were recognized (Meisner 1840). Meisner's earlier contribution on *Lachnaea*, with some alterations, was published in De Candolle's *Prodromus* in

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which 18 species and 17 infraspecific taxa were recognized (Meisner 1857). The most recent taxonomic treatment of the genus was that of Wright (1915) in *Flora capensis*. In this treatment no mention was made of the sections established by Meisner. Wright (1915) recognized 19 species and eight infraspecific taxa, and referred to one imperfectly known species. In the Addenda to the same volume, a further two species and two infraspecific taxa were added (Wright 1925). Since then four new species have been described, namely three by Compton (1934a & b, 1953) and one by Fourcade (1934). When Thoday (1924) published the revision of the genus *Passerina*, he noted that the type of *Passerina laniflora* C.H. Wright was not a *Passerina* species but indeed a species of *Lachnaea*. Bond (1982) proposed the new combination, *Lachnaea laniflora* (C.H. Wright) Bond. *L. marlothii* Schltr. (Schlechter 1896) and *L. gracilis* Meisn. (Meisner 1840) were both overlooked by Wright. At present 29 species and eight infraspecific taxa are recognized (Van Wyk 1993).

The genus *Cryptadenia*, comprising five species, was established by Meisner in 1840 and was also based on Drège's collections (Meisner 1840). According to Meisner (1840) the main characters by which *Cryptadenia* can be distinguished from the closely related genus *Lachnaea*, are the glands which are positioned much lower down in the hypanthium just above the ovary, and by the conspicuous filaments which are adnate to the hypanthium. In De Candolle's *Prodromus* the same five species were recognized by Meisner (1857). The most recent taxonomic treatment of *Cryptadenia* was that of Wright (1915) in *Flora capensis*, in which four of the species in Meisner's treatment were recognised, whereas one was reduced to synonymy. A new species was also described. The criterion used by Wright (1915) to delimit the two genera was the position of the flowers: 'Flowers axillary, solitary' in *Cryptadenia* opposed to 'Flowers terminal, capitate, rarely solitary' in *Lachnaea*. At present *Cryptadenia* is considered to comprise five species (Van Wyk 1993).

Both *Lachnaea* and *Cryptadenia* are endemic to the Cape Province. *Lachnaea* is found mainly at high altitudes from Clanwilliam in the north to the Cape Peninsula in the south and eastwards along the coastal areas as far as Uitenhage. Further inland it occurs on the mountain ranges from Ceres through Worcester to Ladismith (Bond & Goldblatt 1984). The centre of diversity is in the south-western area. *Cryptadenia* occurs on sandy flats and lower mountain slopes from Piketberg in the west to the Cape Peninsula, and along the coastal areas to Bredasdorp and inland to Ceres (Bond & Goldblatt 1984).

Lachnaea and its closest related genus, *Cryptadenia*, are both characterized by the absence of petals and by a hypanthium having scales below the insertion of the stamens. Beyers & Van der Walt (1994), contrary to Wright (1915), found that the two genera could not be distinguished on the inflorescence structure. With the large number of herbarium specimens now available, compared to the small range of material on which earlier studies were based, a sound delimitation of the two genera is possible. The aim of the present investigation was to compare the two genera using a multidisciplinary approach, with the view to establishing whether they are congeneric

or not. Besides the morphological study accompanied by field work, anatomical, palynological and karyological investigations were undertaken to assess the taxonomic value of the evidence derived from these sources.

MATERIALS AND METHODS

Eighteen taxa were selected, 14 from *Lachnaea* and four from *Cryptadenia*. The aim in selecting the taxa was to have as broad a representation as possible of all the taxa in the two genera. The criteria used for selecting the *Lachnaea* taxa were as follows: a, taxa representative of the three sections instituted by Meisner (1840), taking into account the variation in each section; b, all taxa with solitary flowers; c, the position of the scales in the floral tube; d, the stigma types; e, the degree of asymmetry of the calyx lobes.

Wright's revision of *Lachnaea* and *Cryptadenia* in *Flora capensis* (1915 and 1925) was followed. Type specimens and quoted specimens were examined to verify the species concepts for the taxa used in this study. Intraspecific variation has been included in each taxon studied and has not been treated individually.

Four of the five species of *Cryptadenia* currently recognized were studied. *Cryptadenia breviflora* Meisn. was excluded as it is an intermediate taxon between *Cryptadenia grandiflora* (L. f.) Meisn. and *Cryptadenia uniflora* Meisn., which Levyns (1950) considered to be a hybrid between these two species.

The following species were studied: *Lachnaea aurea* Eckl. & Zeyh., *L. axillaris* Meisn., *L. burchellii* Meisn., *L. buxifolia* Lam., *L. capitata* (L.) Meisn., *L. densiflora* Meisn., *L. diosmoides* Meisn., *L. ericoides* Meisn., *L. eriocephala* L., *L. filamentosa* (Thunb.) Meisn., *L. nervosa* Meisn., *L. penicillata* Meisn., *L. ruscifolia* Compton, *Cryptadenia filicaulis* Meisn., *C. grandiflora*, *C. laxa* C.H. Wright and *C. uniflora* (author citations according to Van Wyk 1993).

For the anatomical study of the foliage leaves, both material preserved in FAA and herbarium material was used. The herbarium material was soaked in 50% ethanol for 24 hours, thereafter treated as preserved material. The preserved material was dehydrated and embedded in wax according to the tertiary butyl method (Johansen 1940). Transverse sections 12 µm thick were made through the middle of the leaf blade with the aid of a rotary microtome and stained with Alcian Green Safranin (AGS) (Joel 1983). Scanning electron micrographs of the leaf surfaces were obtained by mounting portions from the same region of the leaf blade of herbarium material on stubs which were coated with gold and studied with a Joel JSM-35 scanning electron microscope. Epidermal cell patterns of the leaf blade were studied under a light microscope after the adaxial and abaxial epidermal layers were peeled off and mounted in water.

The anatomical study of the flowers was done on material preserved in FAA. The preserved material was dehydrated and embedded in wax according to the tertiary butyl method (Johansen 1940). For the anatomy, transverse

TABLE 1.—Voucher specimens of *Lachmaea* species for the leaf anatomy, floral anatomy, pollen morphology and karyology

Species	Voucher specimens	Leaf anatomy	Floral anatomy	Pollen morph.	Karyology
<i>aurea</i>	<i>Beyers 135</i> (STE)	×		×	
<i>axillaris</i>	<i>Beyers 127, 180</i> (STE)	×	×		
	<i>Beyers 197</i> (STE)		×		
	<i>Schlechter 7702</i> (BOL)	×			
	<i>Steyn 331</i> (NBG)			×	
<i>burchellii</i>	<i>Oliver 9241</i> (STE)	×		×	
	<i>Oliver 9251</i> (STE)	×			
<i>buxifolia</i>	<i>Beyers 118</i> (STE)		×	×	
	<i>Beyers 122</i> (STE)	×		×	
	<i>Taylor 8648</i> (STE)			×	
<i>capitata</i>	<i>Beyers 128</i> (STE)		×	×	
	<i>Beyers 138</i> (STE)	×			
	<i>Hugo 231</i> (STE)			×	
<i>densiflora</i>	<i>Beyers 115</i> (STE)	×		×	
	<i>Beyers 117</i> (STE)			×	
	<i>Beyers 145</i> (STE)	×		×	×
	<i>Beyers 171</i> (STE)	×			
	<i>Beyers 177</i> (STE)	×			
<i>diosmoides</i>	<i>Beyers 181</i> (STE)	×	×	×	×
	<i>Spreeth 158</i> (STE)	×			
	<i>Van Niekerk 53</i> (BOL)			×	
<i>ericoides</i>	<i>Beyers 172</i> (STE)	×			×
	<i>McDonald 1842</i> (STE)			×	
	<i>Zeyher 3776</i> (SAM)			×	
<i>eriocephala</i>	<i>Beyers 54</i> (STE)	×	×	×	×
	<i>Spreeth 141</i> (STE)			×	
<i>filamentosa</i>	<i>Beyers 110</i> (STE)	×		×	
	<i>Taylor 10770</i> (STE)			×	
<i>filicaulis</i>	<i>Beyers 125</i> (STE)	×		×	
	<i>Du Toit s.n.</i> (STE)				×
<i>nervosa</i>	<i>De Kock 152</i> (STE)	×		×	
<i>penicillata</i>	<i>Beyers 173</i> (STE)	×		×	
	<i>McDonald 16321</i> (STE)			×	
	<i>Oliver & Fellingham 9145</i> (STE)			×	
<i>ruscifolia</i>	<i>Beyers 193</i> (STE)	×			
	<i>Goldblatt & Manning 8870</i> (STE)	×			
	<i>Vlok 2084</i> (STE)	×	×	×	

sections were used almost exclusively and longitudinal sections were resorted to only to verify the points of attachment of the floral structures. Serial sections were cut 12 µm in thickness. AGS staining (Joel 1983) as well as Crystal Violet and Erythrosin staining (Jackson 1926) were used. The AGS staining technique was found to give better results.

Pollen was taken from herbarium specimens and from material collected in the wild. For both light microscopy (LM) and scanning electron microscopy (SEM), pollen was acetolyzed according to Erdtman (1960). Acetolyzed samples were prepared for both SEM and LM according to the method of Marais (1990). At least 20 pollen grains of each taxon were measured. Transverse sections ± 15 µm thick were made with the aid of a freeze-microtome to study the structure of the pollen wall of two taxa in

each genus. The terminology used to describe the pollen morphology is that of Walker & Doyle (1975).

For chromosome studies inflorescences were fixed in Carnoy's fixative in the field. After 24 hours, the fixative was replaced with 85% ethanol for 15 minutes and then finally replaced with 70% ethanol. Flower buds were stained in Snow's fluid (1963). The anthers were removed and squashed in 45% acetic acid.

Voucher specimens for the anatomy of leaves and flowers and for pollen morphology and karyology are given in Tables 1 and 2.

RESULTS

Habit

In *Lachmaea* the species are sparsely to densely branched, erect shrubs or erect to sprawling shrublets 0.15–2.00 m high. There is considerable variation in appearance and size among, and sometimes within species. The *Cryptadenia* species are erect or sprawling, moderately to densely branched shrublets 0.12–0.80 m high. In both genera the species are either basally single-stemmed, multi-stemmed, or single-stemmed and multi-stemmed within a single species. The branches are leafy, usually with an adpressed pubescence, later becoming naked and glabrous, and usually marked with the leaf scars of the fallen leaves.

Morphology of foliage leaves

In *Lachmaea* the leaves are alternate or decussate, but in *L. burchellii* they are opposite or subopposite and in *L. diosmoides* they are alternate to subopposite. The leaves are adpressed, ascending, patent or occasionally reflexed, and imbricate to scattered. The leaves in *Cryptadenia* are decussate, adpressed, ascending or sub-patent, and imbricate or scattered. In both genera the orientation and position of the leaves on the axis may vary inter- and intraspecifically.

TABLE 2.—Voucher specimens of *Cryptadenia* species for the leaf anatomy, floral anatomy, pollen morphology and karyology

Species	Voucher specimens	Leaf anatomy	Floral anatomy	Pollen morph.	Karyology
<i>filicaulis</i>	<i>Boucher 5071</i> (STE)	×	×		
	<i>Esterhuysen 34370</i> (BOL)			×	
	<i>McDonald 1989</i> (STE)				×
	<i>Oliver 9803</i> (STE)	×	×		
<i>grandiflora</i>	<i>Beyers 129, 151</i> (STE)	×		×	
	<i>Beyers 196</i> (STE)		×		
<i>laxa</i>	<i>Bohus 7875</i> (BOL)	×		×	
	<i>I. Oliver 4</i> (STE)	×	×		
<i>uniflora</i>	<i>Beyers 136</i> (STE)	×	×	×	×
	<i>Haynes 447</i> (STE)			×	

The leaves in both genera are always entire and usually sessile except in *L. ruscifolia* where they may be subpetiolate. The shape of the leaves in *Lachnaea* can be linear-elliptic to elliptic, oblanceolate, obovate or ovate (Figures 1, 2). Again, the variability is not only among the species but may be within a particular species (Figure 2). The leaves range in size from $2-34 \times 0.6-9.0$ mm. Within some species, as in *L. filamentosa* (Figure 2), the variation in leaf size may be considerable, namely from $5-34 \times 1.8-12.0$ mm. In *Cryptadenia* the shape of the leaves can be lanceolate, narrowly elliptic, narrowly ovate or obovate. In *C. uniflora* the leaves are always narrowly elliptic but in *C. grandiflora* they are narrowly elliptic, narrowly obovate, obovate or oblanceolate. As in *Lachnaea* the shape and size of the leaves vary inter- and intraspecifically (Figure 3). The range in leaf size is $2.9-12.8 \times 0.6-3.2$ mm. The leaves in both genera are coriaceous but in *L. densiflora* they are occasionally semi-succulent.

In *Lachnaea* the abaxial side of the leaves may be flat, obtusely convex to convex, or faintly keeled or keeled in the distal half. Adaxially they may be flat, obtusely concave or concave. Both surfaces of the leaves are usually smooth. However, the abaxial surface in *L. ruscifolia* and *L. nervosa* has several longitudinal ribs, whereas in *L. diosmoides* there is only a single midrib. The abaxial surface is usually green and shiny, whereas the adaxial surface is usually pale green, dull and white-punctulate but in some species the leaves are concolorous. The con-

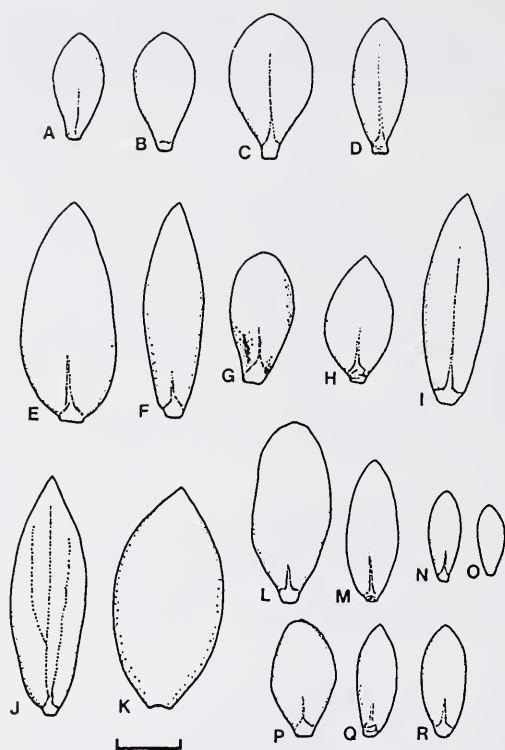


FIGURE 2.—*Lachnaea buxifolia* and *L. filamentosa*. Variation in leaf shape and size, abaxial view. A–I, *L. buxifolia*: A–C, McDonald 1683; D, Marais s.n.; E–G, Beyers 118; H & I, Beyers 122. J–R, *L. filamentosa*: J & K, Low 1246; L & M, Beyers 109; N & O, Beyers 118; P–R, Taylor 12001. Scale bar: 6 mm.

colorous leaves are usually green but in *L. buxifolia*, and sometimes in *L. filamentosa*, they are glaucous. In *Cryptadenia* the abaxial side of the leaves is convex, faintly

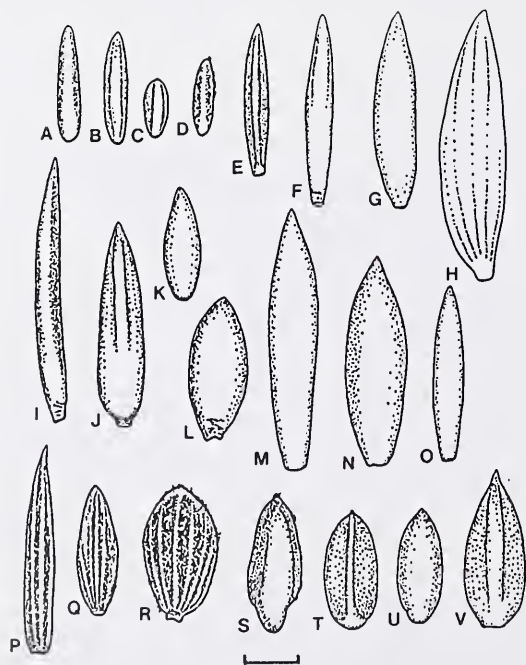


FIGURE 1.—*Lachnaea*. Variation of leaf shape and size, abaxial view. A, *L. eriocephala*, Beyers 54; B & C, *L. ericoides*, Beyers 172; D, *L. funicaulis*, Beyers 125; E, *L. diosmoides*, Beyers 181; F, *L. capitata*, Beyers 128; G & H, *L. burchellii*; G, Oliver 9251; H, Spreeth 155. I–L, *L. densiflora*: I & J, Oliver 9129; K, Taylor 12023; L, Beyers 171. M–O, *L. aurea*, Beyers 135; P & Q, *L. nervosa*, De Kock 152; R, *L. ruscifolia*, Beyers 193; S, *L. penicillata*, Beyers 173. T–V, *L. axillaris*: T, McDonald 1395; U & V, Beyers 197. Scale bars: A–R, 3 mm; S–V, 1 mm.

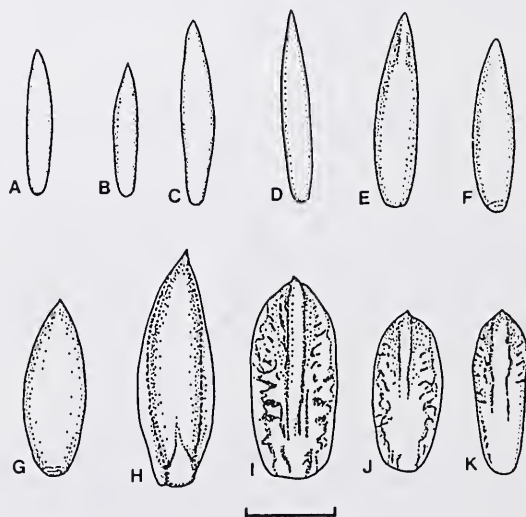


FIGURE 3.—*Cryptadenia*. Variation in leaf shape and size, abaxial view. A–C, *C. filicaulis*: A, McDonald 1988; B & C, Oliver 9803. D, *C. uniflora*, Beyers 136; E & F, *C. laxa*, I. Oliver 4. G–K, *C. grandiflora*: G, Beyers 136; H, Vlok 2179; I–K, Beyers 129. Scale bar: 3 mm.

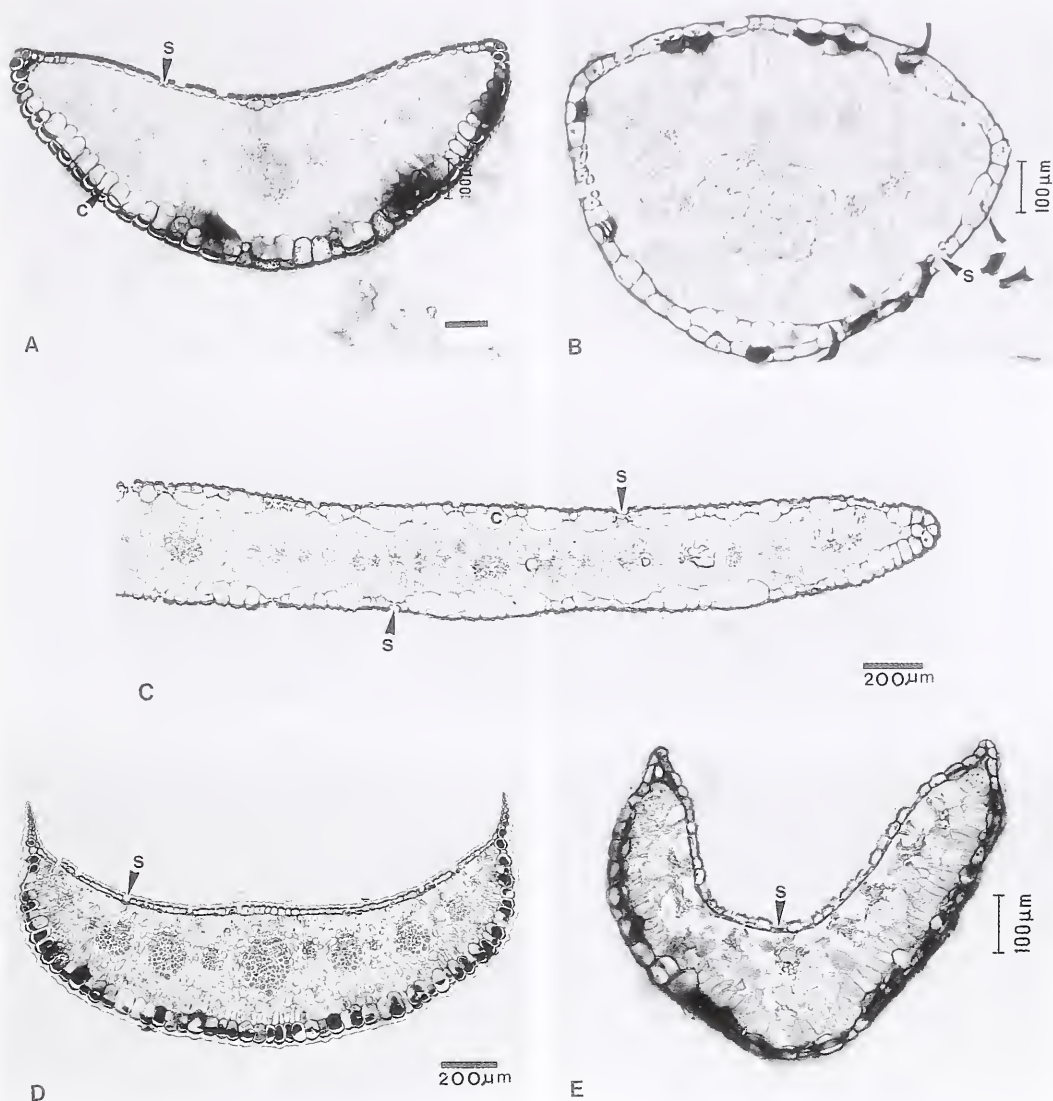


FIGURE 4.—*Lachnaea* and *Cryptadenia*. Leaf transections, adaxial face above. A, *L. eriocephala*, Beyers 54; B, *L. densiflora*, Beyers 115; C, *L. buxifolia*, Beyers 122; D, *C. grandiflora*, Beyers 151; E, *C. laxa*, I.Oliver 4. c, large cells of inner layer of biserial epidermis; s, stoma. Scale bars: A, B, E, 100 µm; C, D, 200 µm.

keeled or keeled, smooth or transversely rugulose towards the margins with a shiny, green surface, whereas adaxially they are concave with a smooth, dull, pale green, white-punctulate surface.

In *Lachnaea* the leaves are glabrous or pubescent at the margins but the marginal pubescence is often deciduous, whereas in *Cryptadenia* the leaves are always glabrous.

Anatomy of foliage leaves

In transverse sections the leaves of most *Lachnaea* species and all *Cryptadenia* species appear concave adaxially and convex abaxially (Figure 4A, D, E), but in

L. densiflora both surfaces are flat or the adaxial one may be slightly convex (Figure 4B); in *L. buxifolia* (Figure 4C) and *L. filamentosa* both surfaces are flat.

Cuticle

In *Lachnaea* the cuticle is well developed and of even thickness on both sides, or thicker on the abaxial side, whereas in *Cryptadenia* the well-developed cuticle is always thicker abaxially. Under the SEM the adaxial and abaxial cuticles of the *Lachnaea* species are unsculptured (Figure 5A, D), undulate (Figure 5B, E) or minutely papillate (Figure 5C, F). In *Cryptadenia* the cuticle is usually minutely papillate adaxially, as in *C. grandiflora* (Figure 6A), but in *C. filiculit* it is unsculptured (Figure 6B). The relief of the

abaxial cuticle is either minutely papillate (Figure 6C) or undulate (Figure 6D). In *C. grandiflora*, however, both types of cuticular sculpturing occur abaxially.

Waxes in the form of small flakes occur commonly on the adaxial leaf surfaces of *Cryptadenia* species and most *Lachnaea* species (Figure 7A, C). In both genera, when waxes are present on the abaxial surface, they are sparse and flakelike (Figure 7B, D). Cutter (1978) is of the opinion that it is this wax deposit that gives the 'bloom' to glaucous leaves.

Trichomes, when present, are non-glandular and uniseriate in both genera.

Epidermis

In both genera the adaxial epidermis is composed of small cells with thin anticlinal and inner tangential walls and slightly thicker outer tangential cell walls. In *L. eriocephala* the outer tangential cell walls are the thickest (Figure 4A). In *Lachnaea* and *Cryptadenia* the adaxial epidermis is uniseriate as in *L. eriocephala* (Figure 4A)

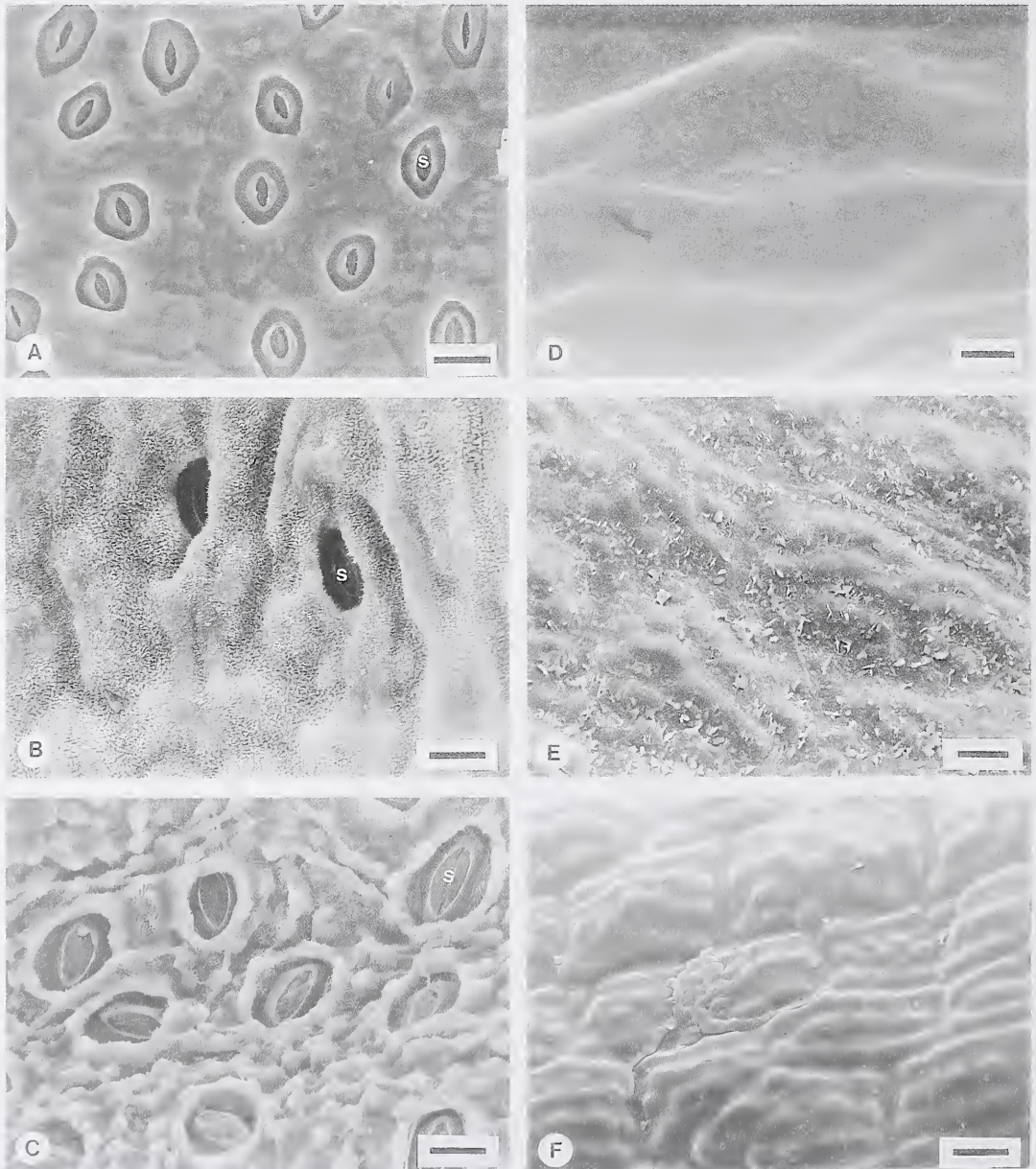


FIGURE 5.—*Lachnaea*. SEM micrographs of cuticular relief of leaf. A–C, adaxial surface: A, *L. funicaulis*, Beyers 125, smooth; B, *L. buxifolia*, Beyers 122, undulate; C, *L. ericoides*, Beyers 172, minutely papillate. D–F, abaxial surface: D, *L. ericoides*, Beyers 172, smooth; E, *L. diosmoides*, Beyers 181, undulate; F, *L. funicaulis*, Beyers 125, minutely papillate. s, stoma. Scale bars: A–F, 20 μ m.

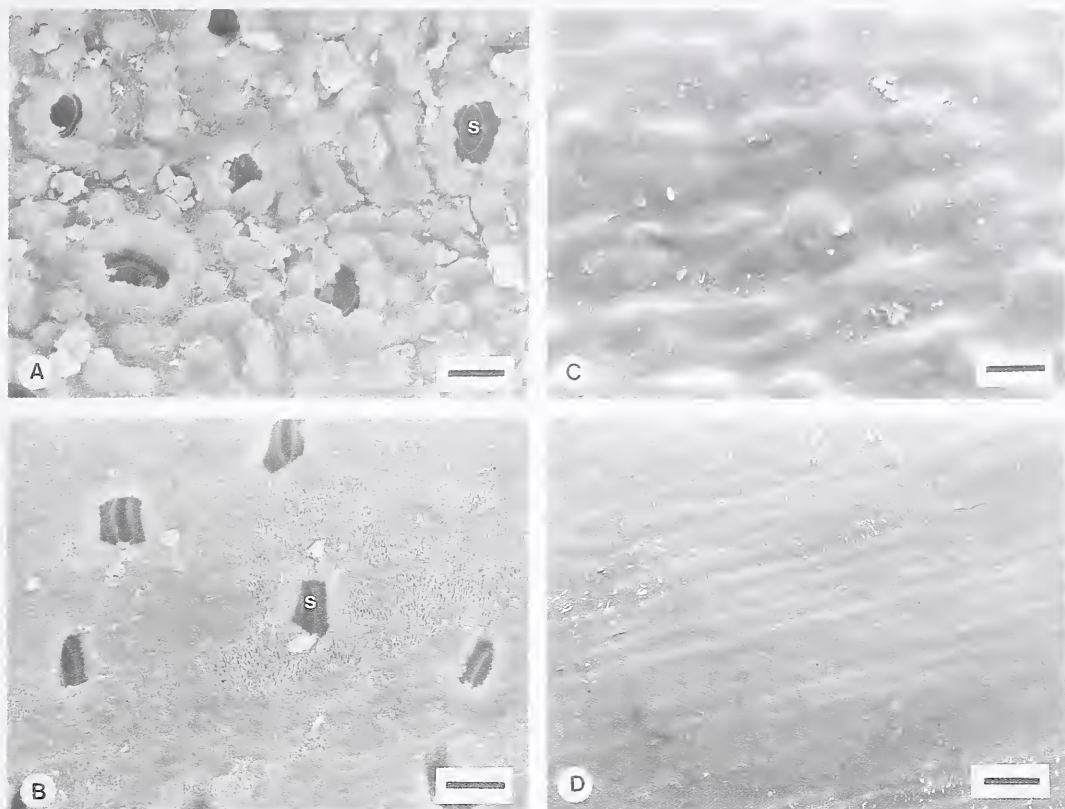


FIGURE 6.—*Cryptadenia*. SEM micrographs of cuticular relief of leaf. A, B, adaxial surface: A, *C. grandiflora*, Beyers 129, minutely papillate; B, *C. filicaulis*, Boucher 5071, smooth. C, D, abaxial surface: C, *C. grandiflora*, Beyers 129, minutely papillate; D, *C. filicaulis*, Boucher 5071, undulate. s, stoma. Scale bars: A–D, 20 µm.

and *C. grandiflora* (Figure 8D, E), incompletely uniseriate (occasional cells with periclinal walls) as in *L. ericoides* (Figure 8A) and *C. uniflora* (Figure 8C), incompletely biseriate (occasional cells without periclinal walls) as in *L. densiflora* (Figure 4B) and *C. laxa* (Figure 4E) or biseriate as in *L. buxifolia* (Figure 4C). The abaxial epidermis is usually biseriate in both genera. However, in *L. axillaris* and *L. ericoides* (Figure 8A) it is incompletely biseriate and in *C. grandiflora* it may be uniseriate (Figure 8D) or incompletely biseriate (Figure 8E).

When the epidermis is biseriate, the cells of the inner layer are usually larger than those of the outer layer. The epidermis contains mucilage, except in *C. grandiflora* where it was not always observed. The mucilage may be present in the cells of the inner and outer epidermal layers, or in the cells of the inner layer only.

Tannin occurs in the epidermis of *L. axillaris*, *L. burchellii*, *L. diosmoides*, *L. ericoides*, *L. funicaulis*, *L. penicillata*, *C. grandiflora* and *C. uniflora*.

Druse crystals were observed in the epidermis of *L. buxifolia*, *L. filamentosa* and *L. ruscifolia*, and sometimes in the adaxial epidermis of *C. grandiflora*.

Stomata

The stomata in both genera are anomocytic and sunken except in *L. funicaulis* and *L. penicillata* where they are on the same level as the outer walls of the surrounding epidermal cells. In *Lachnaea* the leaves are epistomatic or amphistomatic but in *Cryptadenia* they are only epistomatic. When the leaves are amphistomatic, there are usually more stomata adaxially.

Mesophyll

In both genera the cells of the mesophyll are chlorenchymatous and palisade-like (elongated perpendicular to the axis) with the exception of *C. grandiflora* where they are either palisade-like (Figure 8E) or short and more or less round (Figure 8D). As a result of the size of the intercellular spaces, the leaves can be classified as dorsiventral or isobilateral. When dorsiventral, the smaller intercellular spaces occur abaxially and the larger ones adaxially as in *L. axillaris*, *L. diosmoides* (Figure 8B), *L. ericoides*, *L. eriocephala*, *L. funicaulis*, *L. nervosa*, *L. penicillata*, *C. filicaulis*, *C. laxa* and *C. uniflora* (Figure 8C). The isobilateral arrangement occurs in *L. aurea*, *L. burchellii*, *L. buxifolia*, *L. capitata*, *L. densiflora* (Figure 4B), *L. filamentosa* and *L. ruscifolia*. In *C. grandiflora*

however, a dorsiventral or an almost isobilateral arrangement is found.

Tannin occurs in the parenchymatous cells surrounding the median vascular bundle in *L. penicillata* and sometimes in the mesophyll in *C. grandiflora*.

Druse crystals are present in the mesophyll of *L. aurea*, *L. axillaris*, *L. burchellii*, *L. buxifolia*, *L. capitata*, *L. densiflora*, *L. filamentosa*, *L. nervosa* and the four *Cryptadenia* species, and in the vascular tissue of *L. filamentosa*.

Venation and vascular bundles

The venation in both genera is reticulate and the vascular bundles are collateral. As Metcalfe & Chalk (1950) stated, no internal phloem occurs in the midrib.

In both genera, extraxylary fibres occur abaxially in association with the vascular bundles. A prominent median fibre strand (Figure 8) is present in all the species except in *L. buxifolia* and *L. filamentosa*. In addition to the prominent median fibre strand, equally prominent fibre strands occur in association with the larger lateral vascular bundles in *L. nervosa*, *L. ruscifolia* and *C. grandiflora* (Figure 8E). In *L. ruscifolia* the median and larger lateral strands extend to the abaxial epidermis.

Extraxylary fibres not associated with the vascular bundles, occur along the lateral margins immediately below the epidermis in *L. aurea* (Figure 8F).

Morphology of flower and fruit

Pedicel/flower articulation

The flowers in *Lachnaea* are either sessile or shortly pedicellate with pedicels up to 2.5 mm long. In *Cryptadenia* the flowers are always sessile. In *L. eriocephala*, *L. funicularis* and *L. penicillata* the sericeous to villous pedicels elongate in the fruiting stage and remain on the plant long after the fruit has been shed. These hairy pedicels are responsible for the woolly appearance of the old inflorescences. The flowers of *Lachnaea* and *Cryptadenia* are at their bases surrounded by a ring of trichomes, which occurs at the floral articulation of the sessile flowers or on the pedicels.

Hypanthium

In *Lachnaea* the basal portion of the hypanthium is ellipsoid to widely ellipsoid, ovoid to widely ovoid, or obovoid, whereas the portion above the plane of circumscision is funnel-shaped, cylindrical, obconical, cup-shaped or cup-shaped with a sigmoid curve at the base (Figure 9). In *Cryptadenia* the basal portion of the hypan-

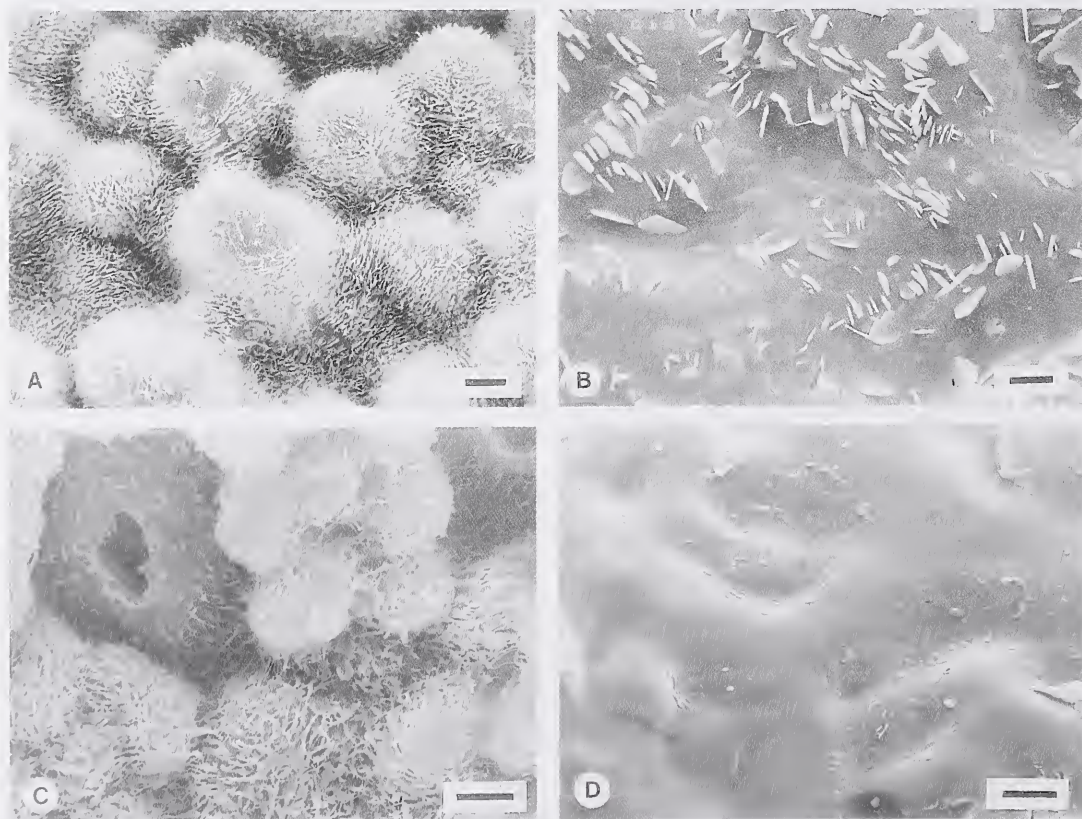


FIGURE 7.—*Lachnaea* and *Cryptadenia*. SEM micrographs of flaky surface wax on leaf. A, B, *L. aurea*, Beyers 135; A, adaxial surface; B, abaxial surface. C, D, *C. laxa*, Bohus 7875; C, adaxial surface; D, abaxial surface. Scale bars: A–D, 5 μ m.

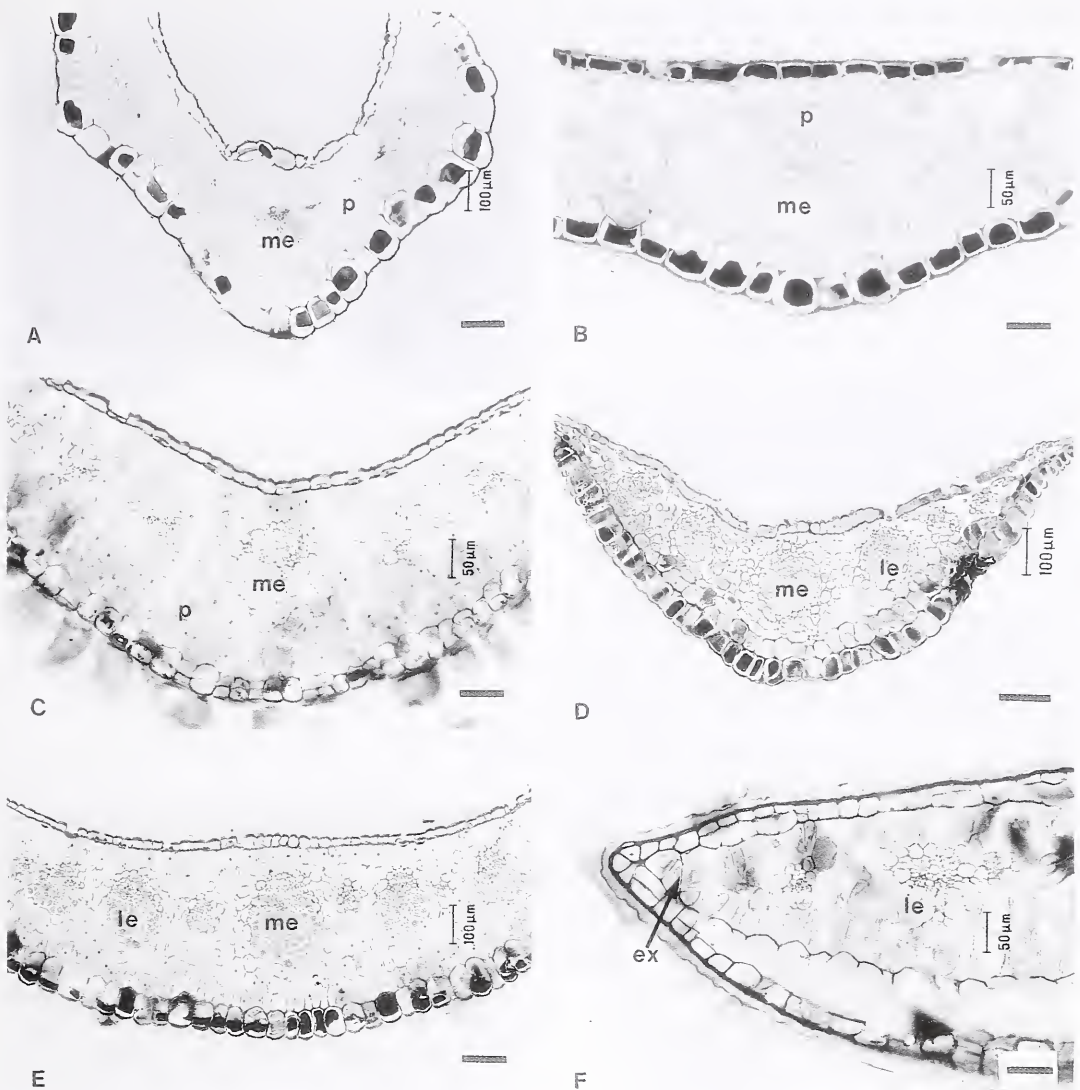


FIGURE 8.—*Lachnaea* and *Cryptadenia*. Leaf transections, adaxial face above. A–E, median vascular bundle: A, *L. ericoides*, Beyers 172; B, *L. diosmoides*, Beyers 181; C, *C. uniflora*, Beyers 136; D, *C. grandiflora*, Beyers 129; E, *C. grandiflora*, Beyers 151. F, leaf margin of *L. aurea*, Beyers 54, showing extraxylary fibres (ex) along lateral margin. p, palisade-like chlorenchyma; me, median extraxylary fibre strand; le, lateral extraxylary fibre strand. Scale bars: A, D, E, 100 µm; B, C, F, 50 µm.

thium is ovoid or ellipsoid, whereas the upper portion above the plane of circumscission is funnel-shaped or cup-shaped (Figure 9). The position of the plane of circumscission, expressed as a percentage of the length of the base to the total length of the hypanthium, varies from 20–80% in both genera. The upper portion of the hypanthium abscises soon after seedset at the plane of circumscission. The length of the hypanthium ranges from 1.5–17.5 mm in *Lachnaea* and from 2.2–11.0 mm in *Cryptadenia*.

The outer surface of the base of the hypanthium is pubescent or glabrous in *Lachnaea* and pubescent in *Cryptadenia*, whereas the inner surface is usually glabrous in both genera, except in *L. buxifolia* and *C. uniflora* where it is pubescent. The outer and inner surfaces of the

upper portion of the hypanthium in both genera are usually pubescent, but in *L. axillaris* the outer surface is glabrous.

In both genera the shape of the trichomes and type of pubescence on the outer surface of the hypanthium often changes around the plane of circumscission. In *L. burchellii* the trichomes on the basal portion are clavate, whereas those on the upper portion are longer and acicular (Figure 10). In *C. laxa* the trichomes of the basal portion are obtuse, whereas those of the upper portion are acicular. The pubescence on the outer surface of the hypanthium is denser in the vicinity of the scales in both *Lachnaea* and *Cryptadenia*. The upper portion of the hypanthium and the calyx are concolorous.

Calyx

The calyx in both genera comprises four sepals which are fused to the rim of the hypanthium. In *Lachnaea* the sepals vary from being almost equal to distinctly unequal, but with a gradual transition from one form to the other (Figure 11). In the distinctly zygomorphic forms the anterior lobe is usually the longest. The sepals are narrowly to widely elliptic, ovate to widely ovate, or obovate to widely obovate. The size of the anterior sepal ranges from $1.3\text{--}22.0 \times 0.8\text{--}7.5$ mm, that of the two lateral sepals from $1.3\text{--}7.5 \times 0.6\text{--}4.5$ mm, and that of the posterior sepal from $1.2\text{--}5.5 \times 0.7\text{--}3.5$ mm. Because the flowers of *L. axillaris* and *L. ruscifolia* are solitary, the outer sepals represent the posterior and anterior sepals and the two inner sepals represent the two lateral sepals. The abaxial surface of the sepals is pubescent, except in *L. axillaris* where it is glabrous. The adaxial surface of the sepals is usually pubescent, but in *L. aurea* and *L. nervosa* it is glabrous and in *L. axillaris* and *L. funiculalis* it is partly glabrous and partly pubescent. The calyx is white, cream, pink, pale blue, white or cream tinged with pink or blue, or yellow.

The sepals in *Cryptadenia* are almost equal (Figure 12), narrowly to widely elliptic, ovate or orbicular, varying in size from $1.6\text{--}10.7 \times 1.2\text{--}5.8$ mm with the apices acute, rounded or obtuse. The abaxial surface is pubescent whereas the adaxial surface is either glabrous or pubescent.

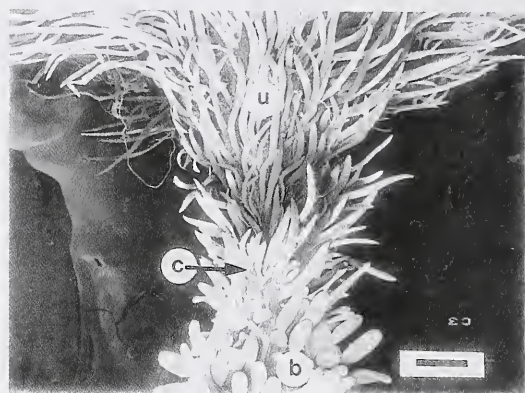


FIGURE 10.—*Lachnaea burchellii*, Oliver 9241. SEM micrograph of trichome structure on outer surface of hypanthium around circumscission zone. b, basal portion of hypanthium; c, plane of circumscission; u, upper portion of hypanthium. Scale bar: 200 μ m.

cent. The calyx is white, cream, white tinged with pink, pink or mauve-pink.

The aestivation of the sepals is decussate-imbricate in *Lachnaea* and *Cryptadenia*.

Petals

Petals are absent in all taxa.

Androecium

Eight stamens in two whorls of four are present in all taxa. In *Lachnaea* the outer whorl, the antisepalous stamens, are episepalous, inserted on the basal portion of the sepals, or they are inserted on the rim of the hypanthium (Figure 11). The stamens of the inner whorl, the antipetalous stamens, are inserted on or very close to the rim of the hypanthium or a third of the way down the throat of the upper portion of the hypanthium as in *L. capitata* (Figure 11F).

In *Cryptadenia* the outer whorl, the antisepalous stamens, are episepalous, fused to the basal portion of the sepals as in *C. grandiflora* and *C. laxa*, or inserted in the upper throat of the hypanthium as in *C. uniflora* and *C. filicaulis* (Figure 12). The inner whorl, the antipetalous stamens, are inserted at the rim of the hypanthium in *C. laxa*, a quarter of the way down in the upper portion of the hypanthium in *C. uniflora* and a third of the way down in *C. filicaulis* and *C. grandiflora* (Figure 12). The stamens are fully exserted in *Lachnaea* (Figure 11). In *Cryptadenia* the antisepalous stamens of all the taxa and the antipetalous stamens of *C. laxa* are exserted. In the other *Cryptadenia* species only the anthers of the antipetalous stamens are exserted or semi-exserted (Figure 12).

The anthers are basifixed and introrse. In *Lachnaea* they are either spherical or oblate-spherical, whereas in *Cryptadenia* they are ellipsoid or ovoid.

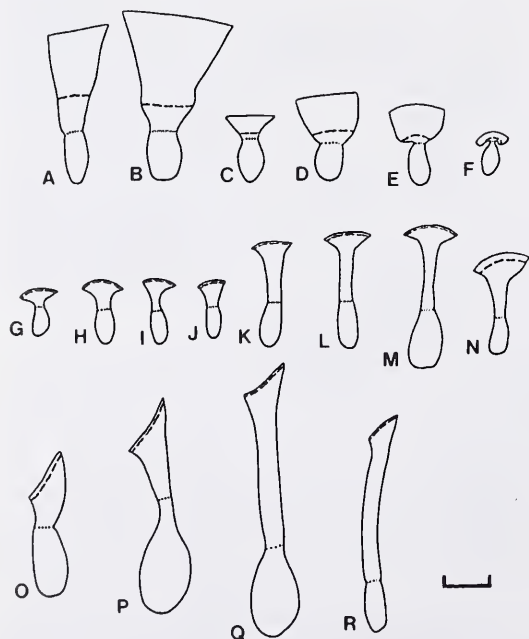


FIGURE 9.—*Lachnaea* and *Cryptadenia*. Hypanthia, showing plane of circumscission, lower dotted line; and scales, upper dashed line. A, *C. uniflora*, Beyers 136; B, *C. grandiflora*, Beyers 129; C, *L. densiflora*, Oliver 9129; D, *L. capitata*, Beyers 138; E, *C. filicaulis*, Thompson 3789; F, *L. axillaris*, Bolus 8596; G, *L. ericoides*, Beyers 172; H, *L. burchellii*, Oliver 9241; I, *L. funiculalis*, Beyers 125; J, *L. peucillata*, Beyers 173; K, *L. ruscifolia*, Vlok 2084; L, *C. laxa*, Bolus 7875; M, *L. nervosa*, De Kock 152; N, *L. diosmoides*, Compton 7580; O, *L. aurea*, Beyers 135; P, *L. filanantosa*, Beyers 110; Q, *L. buxifolia*, Beyers 118; R, *L. eriocephala*, Beyers 54. Scale bar: 2 mm.

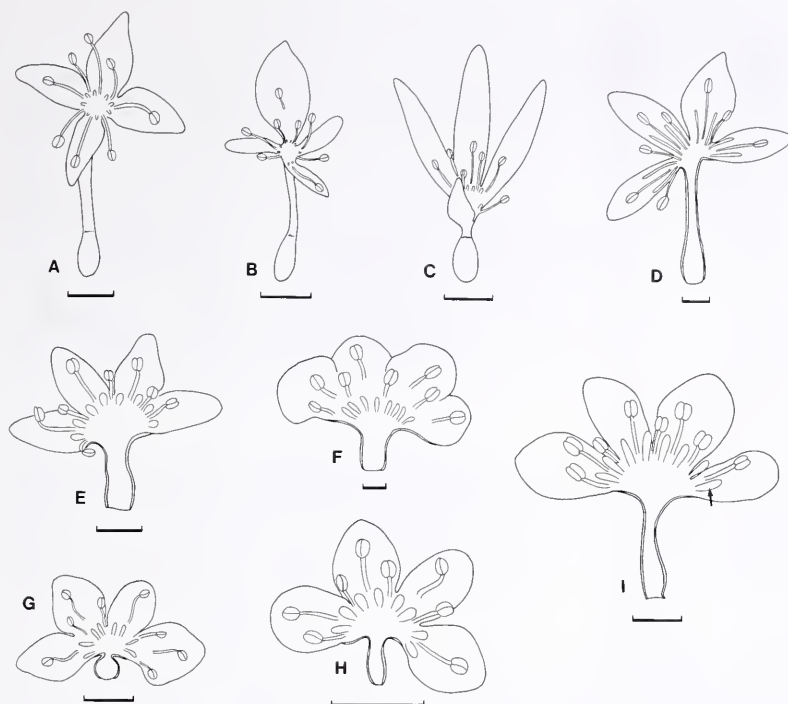


FIGURE 11.—*Lachnaea*. Flowers. A, *L. buxifolia*, Beyers 122; B, *L. filamentosa*, Kruger 977; C, *L. aurea*, Gillett 4343; D, *L. nervosa*, De Kock 152; E, *L. filicaulis*, Marsh 758; F, *L. capitata*, Beyers 138; G, *L. densiflora*, Boucher 1767; H, *L. ericoides*, McDonald 2027; I, *L. penicillata*, Oliver & Fellingham 9145. D–I: flowers split longitudinally with gynoecia removed; floral scales (arrow in I) shown in each flower below stamens. Scale bars: A–C, 4 mm; D–I, 2 mm.

Scales

Eight scales are inserted on the upper portion of the hypanthium below the attachment of the antipetalous stamens and alternating with the stamens. The position of the scales varies in different species of both genera. In most *Lachnaea* species the scales are inserted at the mouth of the hypanthium but in some species they are inserted two thirds or halfway down the upper portion of the hypanthium (Figure 11). In *Cryptadenia* they are inserted either at the mouth of the hypanthium or from midway to three quarters of the way down the upper portion of the hypanthium (Figure 12).

The shape of the scales varies in the different taxa. They can be linear, clavate, subrotund, capitate, ovoid or obovoid in *Lachnaea*, whereas in *Cryptadenia* they are subrotund, narrowly oblong, oblong or ellipsoid. In both genera the scales are either translucent-white or yellow. They are usually glabrous, except in *L. buxifolia* where they have long stiff trichomes at their apices. In all the *Lachnaea* species and in *C. laxa* the scales are basally attached to the hypanthium. In *C. filicaulis* the scales are basally and partly abaxially attached to the hypanthium, and in *C. grandiflora* and *C. uniflora* they are abaxially attached to the hypanthium.

Disc

A disc is absent in both genera.

Gynoecium

In *Lachnaea* the ovary is sessile, oblong, narrowly ellipsoid, ellipsoid, ovoid or obovoid, $0.5\text{--}4.4 \times 0.2\text{--}2.5$

mm, completely glabrous or glabrous with a tuft of hairs at the apex. In *L. filamentosa* the ovary is usually glabrous with a tuft of hairs at the apex but occasionally it may also be adpressed hairy and tufted at the apex.

In *Cryptadenia* the ovary is sessile, ellipsoid, $0.7\text{--}1.8 \times 0.4\text{--}0.7$ mm, usually glabrous, but in *C. filicaulis* it is

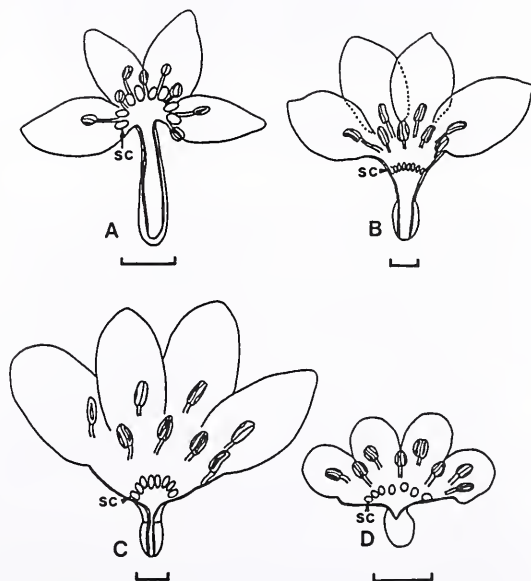


FIGURE 12.—*Cryptadenia*. Flowers split longitudinally with gynoecia removed. A, *C. laxa*, I. Oliver 4; B, *C. uniflora*, Beyers 197; C, *C. grandiflora*, Beyers 151; D, *C. filicaulis*, Thompson 3789. sc, scale. Scale bars: A–D, 2 mm.

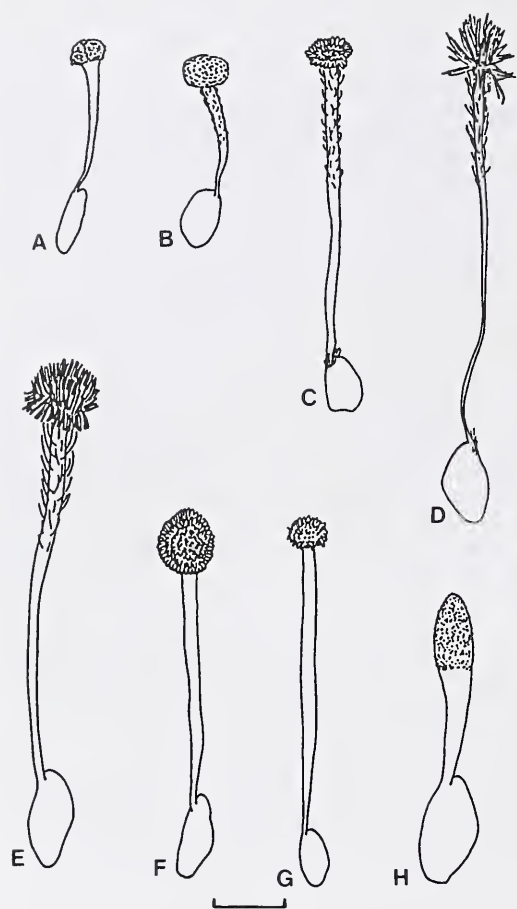


FIGURE 13.—*Lachnaea* and *Cryptadenia*. Gynoecia. A, *L. funiculalis*, Marsh 758; B, *L. ericoides*, Beyers 172; C, *L. ruscifolia*, Goldblatt & Manning 8870; D, *L. nervosa*, De Kock 152; E, *C. laxa*, I. Oliver 4; F, *C. uniflora*, Beyers 197; G, *C. grandiflora*, Leighton BOL21142; H, *C. filicaulis*, Thompson 3789. Scale bars: A–E, H, 1 mm; F, G, 2 mm.

either glabrous or pubescent towards the apex on the side where the style is inserted.

In both genera the ovary is unilocular, with a solitary anatropous ovule laterally attached near the top of the ovary; the style is laterally attached, linear or linear-obconical. The style is either completely glabrous or pubescent in the distal third to two thirds, or completely pubescent in *Lachnaea*, whereas in *Cryptadenia* it is usually glabrous but in *C. laxa* the distal half is pubescent.

The stigma in *Lachnaea* is either brushlike or capitate and papillate, or capitate and elongate-papillate (Figure 13). In *Cryptadenia* it is either conical or capitate and elongate-papillate, or brushlike (Figure 13).

Fruit

The fruit in both genera is an achene which is enclosed in the persistent base of the hypanthium. The pericarp is dry and thin, whereas the seed coat is thick and crustaceous.

Vascular anatomy of the flower

The basic vascular pattern is the same in both genera. The eight traces supplying the calyx, depart from the vascular tissue of the pedicel or the floral axis, where they are arranged in a continuous cylinder (Figure 14A) or in a ring of bundles (Figure 15A) in *Lachnaea* and in a continuous cylinder in *Cryptadenia* (Figure 16A). The eight sepal traces extend upwards in the hypanthium. The lateral bundles of the sepals arise commissurally after the departure of the antipetalous stamen traces (Figure 17A, C, G, H, I) or at the same point of departure of the antipetalous stamen traces (Figure 17B, D, E, F, J) at various levels on the hypanthium. The vascular supply of the sepals consists of a midrib bundle and two lateral bundles.

The stamens are single-trace organs. The antipetalous stamen traces are fused to the commissural sepal traces, and the antisepalous stamen traces to the sepal midrib traces at their point of origin from the stele. The stamen traces separate from the sepal traces in two whorls at different levels in the hypanthium. The antipetalous stamen traces diverge from the commissural sepal bundles before

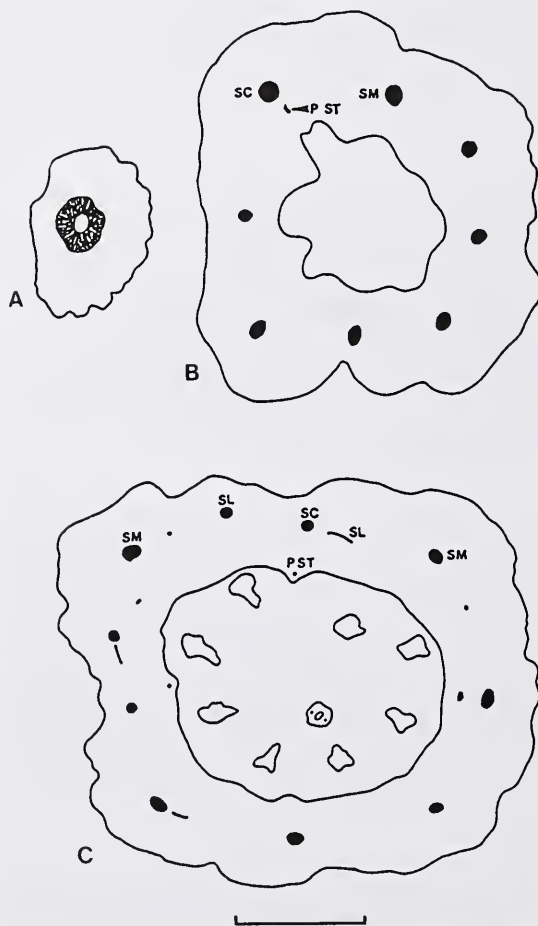


FIGURE 14.—*Lachnaea capitata*, Beyers 128. Floral anatomy. A, trans-section through floral axis. B, C, transsections of flower: B, vasculature of hypanthium, separation of antipetalous stamen trace (PST) from commissural sepal bundle (SC); C, splitting of commissural sepal bundles into sepal lateral bundles (SL). SM, sepal midrib bundle. Scale bar: 500 µm.

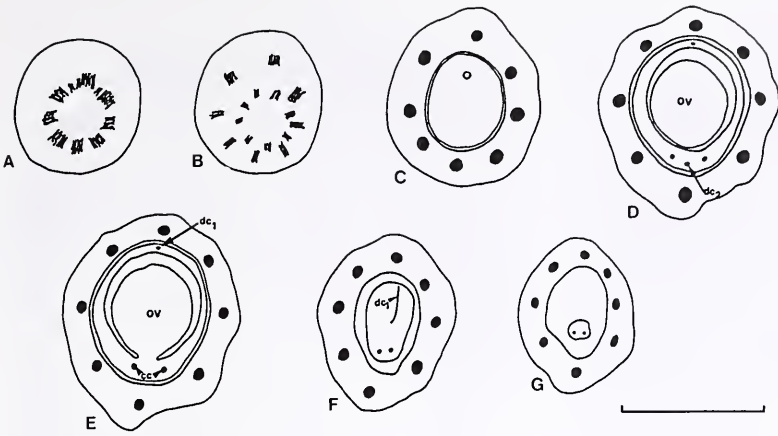


FIGURE 15.—*Lachnaea diosmoides*, Beyers 151. Transsections of flower. A, pedicel showing ring of vascular bundles; B, base of hypanthium showing departure of whorl of eight bundles; C, hypanthium at base of ovary; D, lower portion of ovary; E, middle of ovary; F, top of ovary; G, base of style. o, ovary; ov, ovule; dc1, dorsal carpellary of fertile carpel; cc, commissural carpellary; dc2, dorsal carpellary of sterile carpel. Scale bar: 500 μ m.

the antisepalous stamen traces diverge from the sepal midrib bundles (Figure 14). The antisepalous stamen traces leave the sepal midrib bundles at or just below the rim of the hypanthium, except in *C. filicaulis* (Figure 17H) where they depart a quarter of the way down the upper portion of the hypanthium. The antipetalous stamen traces leave the commissural sepal bundles at various levels on the upper portion of the hypanthium. In *L. buxifolia* (Figure 17F), *L. diosmoides* (Figure 17B), *L. eriocephala* (Figure 17D), *L. ruscifolia* (Figure 17E) and *C. laxa* (Figure 17J) these stamen traces depart near the rim of the tube, in *L. axillaris* (Figure 17C), *C. filicaulis* (Figure 17H), *C. grandiflora* (Figure 17I) and *C. uniflora* (Figure 17G) they depart midway and in *L. capitata* (Figure 17A) they depart three quarters of the way down the tube. The stamens become free from the hypanthium a short distance above the divergence of their traces as in *L. buxifolia* (Figure 17F) and *C. filicaulis* (Figure 17H), or are adnate to the hypanthium for some distance before becoming free as in *L. capitata* (Figure 17A) and *C. uniflora* (Figure 17G). In *L. buxifolia* (Figure 17F), *L. diosmoides* (Figure 17B), *L. eriocephala* (Figure 17D), *C. grandiflora* (Figure 17I) and *C. laxa* (Figure 17J) the antisepalous stamens are adnate to the basal portion of the sepals. In *Cryptadenia*, with the exception of *C. laxa*, the hypanthium, above the insertion of the scales, is further augmented by small median sepal bundles whose stelar extensions have been aborted (Figures 17G, H, I; 18A). Branches of these median sepal bundles may anastomose with the midrib bundles and the commissural sepal bundles. A rich vascular plexus exists in the hypanthium of *C. laxa* at the level of insertion of the scales (Figure 17J).

The eight scales arise as emergences from the adaxial wall of the hypanthium (Figure 19) at different levels on the upper portion of the hypanthium. They emerge a short distance below the divergence of the antipetalous stamen traces from the commissural sepal bundles, as in *L. capitata* (Figure 17A) and in *C. grandiflora* (Figure 17I), or just above the divergence of the antipetalous stamen traces and the lateral sepal traces from the commissural sepal bundles, as in *L. buxifolia* (Figure 17F) and in *C. laxa* (Figure 17J). No vascular tissue is present in or at the base of the scales, even in those taxa in which the scales are inserted in close juxtaposition to the sepal lateral bundles and the sepal midrib bundles. In *Lachnaea* the scales are usually non-glandular (Figure 20A) but in *L.*

axillaris (Figure 20B) they are composed of compact thin-walled cells rich in cytoplasm with large nuclei, thus appearing glandular (Esau 1965). Similarly in *Cryptadenia* the scales are either non-glandular or appear glandular. No secretion was observed from the scales in either genus.

The ovary is bicarpellate. In *Lachnaea* the dorsal carpellary bundle of the fertile carpel is always present, whereas the dorsal carpellary bundle of the sterile carpel is present in *L. capitata* and *L. diosmoides* (Figure 15), but absent in *L. eriocephala* (Figure 21) and *L. axillaris*. In *Cryptadenia* the dorsal carpellary bundle of the fertile carpel is usually present, but absent in *C. filicaulis* (Figure 16) whereas the dorsal carpellary bundle of the sterile carpel is always present (Figure 16).

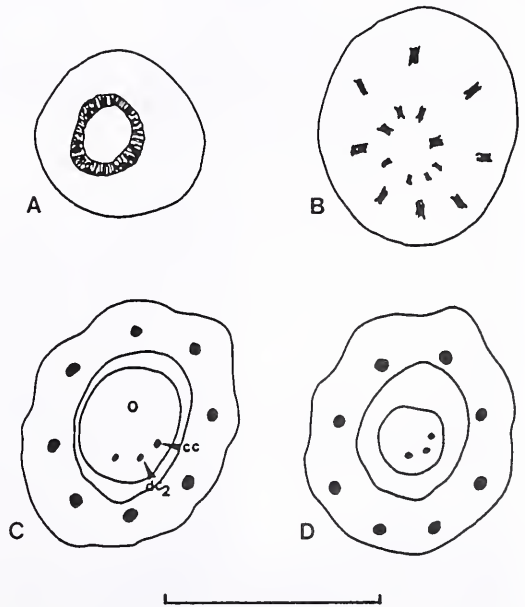


FIGURE 16.—*Cryptadenia filicaulis*, Oliver 9803. A, transection through floral axis. B–D, transsections of flower: B, base of flower showing departure of whorl of eight bundles; C, lower portion of ovary showing abortion of dorsal carpellary of fertile carpel; D, base of style showing commissural carpellaries and dorsal carpellary of sterile carpel entering style. cc, commissural carpellary; dc2, dorsal carpellary of sterile carpel. Scale bar: 500 μ m.

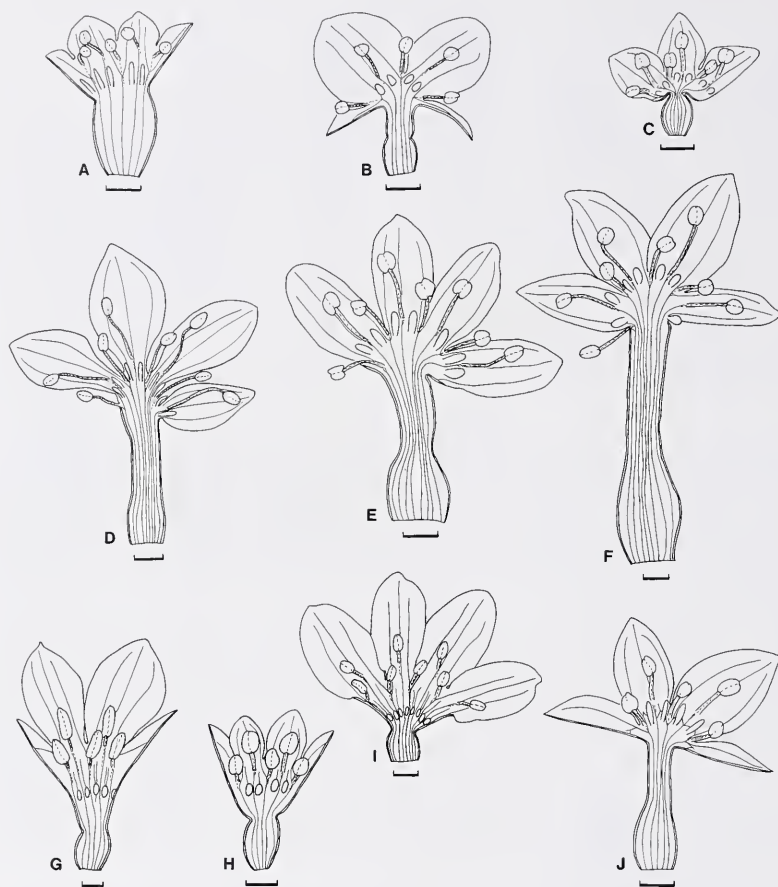


FIGURE 17.—*Lachnaea* and *Cryptadenia*. Vasculature of hypanthium, stamens and sepals. A, *L. capitata*, Beyers 128; B, *L. diosmoides*, Beyers 151; C, *L. axillaris*, Beyers 197; D, *L. eriocephala*, Beyers 54; E, *L. ruscifolia*, Vlok 2084; F, *L. buxifolia*, Beyers 118; G, *C. uniflora*, Beyers 136; H, *C. filicaulis*, Oliver 9803; I, *C. grandiflora*, Beyers 196; J, *C. laxa*, I. Oliver 4. Scale bar: 1 mm.

The commissural carpellary bundles (Heinig 1951) are closely associated with the dorsal bundle of the sterile carpel (Figures 15, 16), or when the latter is absent they are in the associated position (Figure 21).

The vasculature of the style is variable. It may consist of: the commissural carpellary bundles as in *L. diosmoides* (Figure 15), *L. axillaris* and *L. capitata*; the two ventral bundles of the sterile carpel arising from the split commissural carpellary bundles as in *L. eriocephala* (Figure 21); the dorsal bundle of the fertile carpel, the dorsal bundle of the sterile carpel and the commissural carpellary bundles as in *C. grandiflora*; the dorsal bundle of the sterile carpel and the commissural carpellary bundle as in *C. filicaulis* (Figure 16) and *C. uniflora*; or the dorsal bundle of the fertile carpel and the dorsal bundle of the sterile carpel as in *C. laxa*.

Pollen morphology

Pollen grains of the *Lachnaea* and *Cryptadenia* species examined, have the same basic morphology. The grains are monads, globose and polyforate (Figure 22) with a diameter of 22–52 μm in *Lachnaea* and 40–50 μm in *Cryptadenia* (Table 3).

The pollen is tectate and supra-ornate (Figure 22). Erdtman (1971) describes the sculpture pattern as

crotonoid. The sexine is thicker than the nexine. The sexine is attached to the nexine by means of columellae, which unite into a tectum above. The tectum is reticulate with suprategate triangular projections. These suprategate structures are trihedral to shallowly trihedral with the basal sides straight as in *L. buxifolia* (Figure 23A), *L. ruscifolia* (Figure 23B) and *C. uniflora* (Figure 23E) or emarginate as in *L. aurea* (Figure 23C), *L. eriocephala* (Figure 23D) and *C. laxa* (Figure 23F). A vestigial spinule occurs at

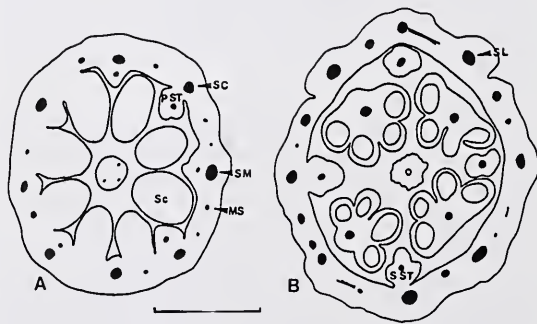


FIGURE 18.—*Cryptadenia filicaulis*, Oliver 9803. Transection of hypanthium of flower. A, at level where scales (Sc) separate from hypanthium; B, where antiseptalous stamens (S ST) separate from tube. P ST, antipetalous stamens; SM, sepal midrib bundle; SC, commissural sepal bundle; SL, sepal lateral bundle; MS, median sepal bundle. Scale bar: 500 μm .

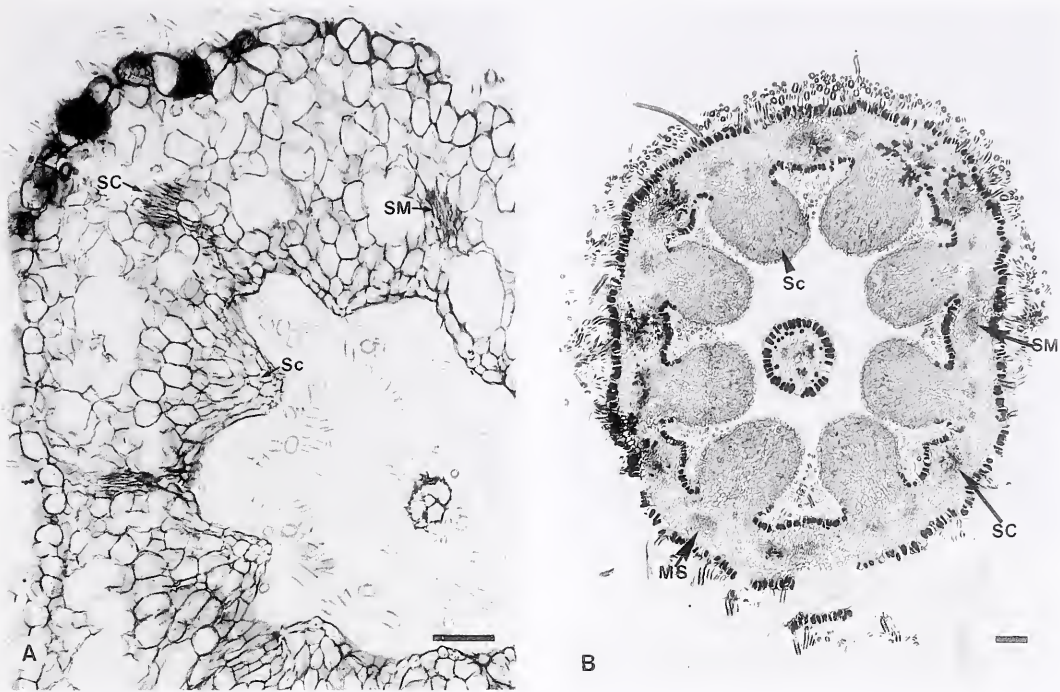


FIGURE 19.—*Lachnaea* and *Cryptadenia*. Floral anatomy of hypanthia. Vasculature and scales (Sc) arising from adaxial wall. A, *L. capitata*, Beyers 128; B, *C. grandiflora*, Beyers 196. SM, sepal midrib bundle; SC, commissural sepal bundle; Sc, scale; MS, median sepal bundle. Scale bars: A, B, 100 μm.

the base of each of the three main ridges in some *Lachnaea* species (Figure 23A, B) but was absent in all the *Cryptadenia* species (Table 4). The surface of the lateral sides of the supracteal trihedral projections is striate in all the species (Figure 23).

Karyology

The haploid chromosome number of $n = 9$ was observed in six species of *Lachnaea* and in two species of

Cryptadenia (Table 5). The meiotic chromosome behaviour was normal.

DISCUSSION

Habit, phyllotaxis and foliage

The habit, phyllotaxis and macromorphological characters of the foliage leaves are rather variable among the

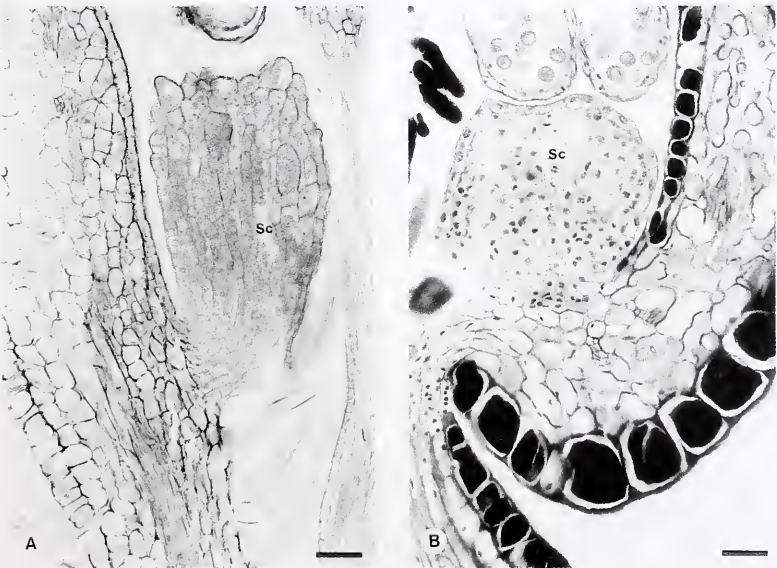


FIGURE 20.—*Lachnaea*. Longitudinal section of scale. A, *L. capitata*, Beyers 128; B, *L. axillaris*, Beyers 127. Sc, scale. Scale bars: A, B, 50 μm.

TABLE 3.—Size range of pollen grains (mean followed by range in parentheses) in *Lachnaea* and *Cryptadenia*

Taxon	Collector	Diameter (µm)
<i>Lachnaea</i>		
<i>aurea</i>	Beyers 135	47 (39–51)
<i>axillaris</i>	Steyn 331	22 (20–23)
<i>burchellii</i>	Oliver 9241	29 (23–37)
<i>buxifolia</i>	Beyers 122	47 (43–53)
	Beyers 118	52 (49–55)
	Taylor 8648	49 (47–59)
<i>capitata</i>	Hugo 231	26 (23–29)
	Beyers 128	29 (23–33)
<i>densiflora</i>	Beyers 145	29 (23–45)
	Beyers 117	32 (29–35)
	Beyers 115	27 (23–31)
<i>diosmoides</i>	Beyers 181	29 (23–33)
	Van Niekerk 53	30 (27–33)
<i>ericoides</i>	McDonald 1842	28 (25–31)
	Zeyher 3776	27 (23–31)
<i>eriocephala</i>	Beyers 54	50 (39–57)
	Spreeth 141	45 (39–55)
<i>filamentosa</i>	Beyers 110	45 (39–55)
	Taylor 10770	50 (47–56)
<i>funicaulis</i>	Beyers 125	25 (20–27)
<i>nervosa</i>	De Kock 152	35 (31–39)
<i>penicillata</i>	Oliver & Fellingham 9145	28 (19–35)
	Beyers 173	29 (23–39)
<i>ruscifolia</i>	Vlok 2084	35 (31–39)
<i>Cryptadenia</i>		
<i>filicaulis</i>	Esterhuysen 34370	33 (29–39)
<i>grandiflora</i>	Beyers 151	48 (45–58)
	Beyers 129	56 (47–64)
<i>laxa</i>	Bolus 7875	40 (33–43)
<i>uniflora</i>	Haynes 477	52 (49–55)
	Beyers 136	54 (47–62)

species and sometimes even within individual species of *Lachnaea* and *Cryptadenia*. The variation range within *Cryptadenia* is smaller than in *Lachnaea* but one must take into account that *Cryptadenia* is a much smaller group of species. With regard to the habit, phyllotaxis and

TABLE 4.—Comparison of sculpturing of supratectal projections of tectate pollen in *Lachnaea* and *Cryptadenia*

Taxon	Base sides		Vestigial spinules at base of main ridges
	± straight	emarginate	
<i>Lachnaea</i>			
<i>aurea</i>	—	+	—
<i>axillaris</i>	+	—	—
<i>burchellii</i>	+	—	+
<i>buxifolia</i>	+	—	+
<i>capitata</i>	+	—	+
<i>densiflora</i>	+	—	+
<i>diosmoides</i>	+	—	+
<i>ericoides</i>	—	+	—
<i>eriocephala</i>	—	+	—
<i>filamentosa</i>	—	+	+
<i>funicaulis</i>	—	+	—
<i>nervosa</i>	+	—	+
<i>penicillata</i>	+	—	+
<i>ruscifolia</i>	+	—	+
<i>Cryptadenia</i>			
<i>filicaulis</i>	+	—	—
<i>grandiflora</i>	+	—	—
<i>laxa</i>	—	+	—
<i>uniflora</i>	+	—	—

TABLE 5.—Chromosome numbers of *Lachnaea* and *Cryptadenia* species studied

Taxon	Haploid chromosome number	Voucher specimen
<i>Lachnaea</i>		
<i>buxifolia</i>	9	Beyers 122
<i>densiflora</i>	9	Beyers 145
<i>diosmoides</i>	9	Beyers 181
<i>ericoides</i>	9	Beyers 172
<i>eriocephala</i>	9	Beyers 54
<i>funicaulis</i>	9	Du Toit s.n.
<i>Cryptadenia</i>		
<i>filicaulis</i>	9	McDonald 1989
<i>uniflora</i>	9	Beyers 136

macromorphological characters of the foliage leaves no major differences were found which could be used to demarcate the two genera.

Based on the anatomy of the leaves, two leaf groups can be distinguished within *Lachnaea*: 1, those which are amphistomatic and either isobilateral or almost centric; 2, those which are epistomatic and either isobilateral or dorsiventral. The leaves of *Cryptadenia* are epistomatic and either almost isobilateral or dorsiventral. The anatomy of the latter resembles that of the second group in *Lachnaea*. Similar cuticular patterns, namely unsculptured, minutely papillate or undulate, occur in both genera. These characters confirm the close relationship between *Cryptadenia* and *Lachnaea*.

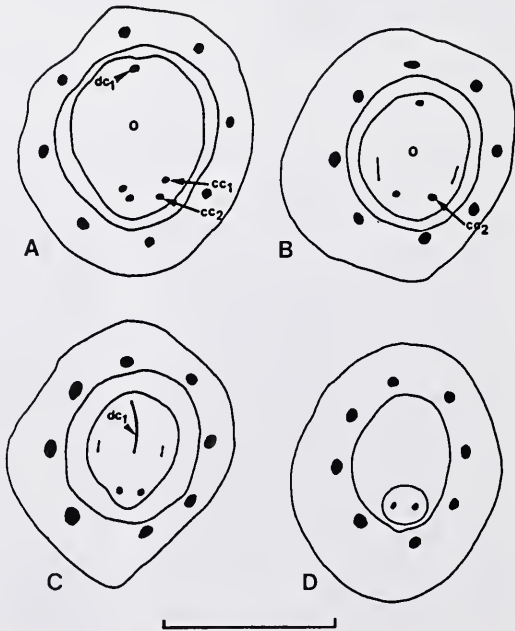


FIGURE 21.—*Lachnaea eriocephala*, Beyers 54. Transections of flower: A, base of ovary; B, upper portion of ovary; C, top of ovary; D, base of style. o, ovary; dc₁, dorsal carpellary of fertile carpel; cc₁, commissural carpellary of fertile carpel; cc₂, commissural carpellary of sterile carpel. Scale bar: 500 µm.

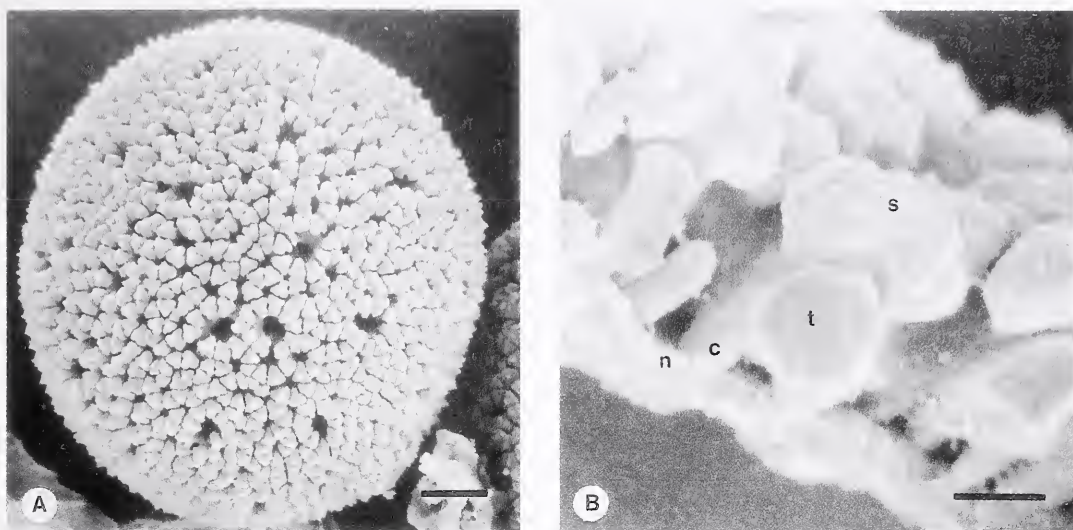


FIGURE 22.—*Lachnaea* and *Cryptadenia*. SEM micrographs of pollen morphology. A, *L. aurea*, Beyers 135, pollen grain; B, *L. buxifolia*, Beyers 122, transection of pollen grain wall. n, nexine; c, columella; t, tectum; s, supracteal structure. Scale bars: A, 5 μ m; B, 1 μ m.

Morphology of flower and fruit

Pedicel/floral articulation

The study of the floral morphology revealed the strong similarity between *Lachnaea* and *Cryptadenia*. Sessile flowers are found in both genera. The ring of trichomes at the base of the flower, occurring at the floral articulation, corresponds to that found by Heads (1990) in *Kelleria* Endl. This structure, according to Heads (1990) is reminiscent of the calycular pappus of many members of the Asteraceae and the peltate hairs of Elaeagnaceae, and could be regarded either as a compressed pubescent 'pedicel' or as the 'calyx' of a sessile flower. The pedicels of pedicellate flowers of *Lachnaea* species are always pubescent. The trichomes at the floral articulation do not differ from those on the pedicel and it is therefore more acceptable to regard the ring of trichomes at the base of the sessile flowers as a compressed pubescent 'pedicel'.

Hypanthium

The nature of the hypanthium of the flower of the Thymelaeaceae has been interpreted as being appendicular (foliar) and representing a calyx tube by Meisner (1857), Wright (1915), Peterson (1959) and Dyer (1975), or as being receptacular by Eichler (1878), Baillon (1880), Gilg (1894), Wettstein (1935), Rendle (1938) and Bunninger (1972). According to Lawrence (1951) the hypanthium is more commonly and inaccurately termed the calyx tube or floral tube. Heads (1990), Heinig (1951) and Saunders (1939) regard the floral tube of the Thymelaeaceae as a hypanthium. The vascular anatomy undertaken in this study has shown that the floral tube in both genera can be regarded as a hypanthium.

The position of the plane of circumscription expressed as a percentage of the total length of the hypanthium varies in both genera between 20% and 80%. The shape,

length and pubescence of the hypanthium of *Cryptadenia* falls well within the variation range found in *Lachnaea*.

Calyx

The sepals in *Lachnaea* vary from being almost equal to distinctly unequal. The transition from one form to the other is gradual. The sepals of *Cryptadenia* are almost equal which was one of the reasons why Baillon (1880) incorporated *Cryptadenia* as a section in *Lachnaea*.

The aestivation of the sepals is the same in both genera and a basic floral vascular pattern is common to both genera.

Androecium

Eight stamens in two whorls of four each are present in both genera. The position of insertion on the floral tube shows a varying degree of adnation within both *Lachnaea* and *Cryptadenia*. The stamens are always exerted in *Lachnaea*, but in *Cryptadenia* they are either exerted or only the antisepalous stamens are fully exerted.

Scales

In the different genera of the Thymelaeaceae organs comparable to the scales in *Lachnaea* and *Cryptadenia* have been interpreted by various authors as petaloid glands, scales, mere outgrowths of the perigynium, aborted stamens, squamellae which should be regarded either as new structures of uncertain origin or as modified parts of the androecium, stipules or petals which might be reduced or greatly modified in form (Heinig 1951).

In *Lachnaea* various views regarding the nature of these scales have been expressed, namely that they should be regarded as staminodes, scales, glandular or scale-like receptacular effigurations, or petaloid scales homologous

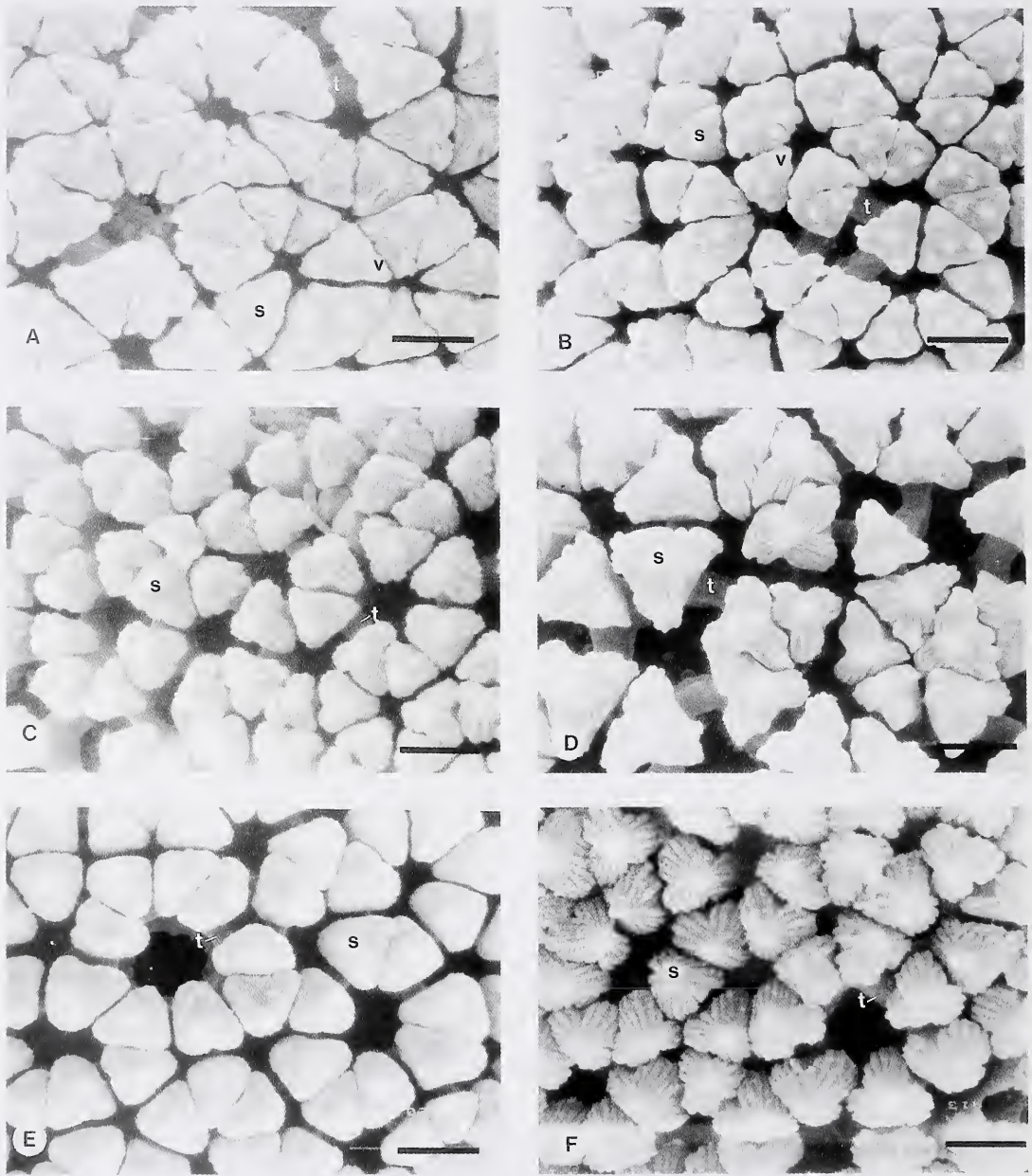


FIGURE 23.—*Lachnaea* and *Cryptadenia*. SEM micrographs of pollen grains. A, *L. buxifolia*, Beyers 122; B, *L. ruscifolia*, Vlok 2084; C, *L. aurea*, Beyers 135; D, *L. eriocephala*, Beyers 54; E, *C. uniflora*, Haynes 477; F, *C. laxa*, Bolus 7875. s, supratectal structure; t, tectum; v, vestigial spinule. Scale bars: A–F, 2 μ m.

to petals. In those species of *Lachnaea* where these structures are narrowly straplike or filiform, Domke (1934) regarded them to be in their original form and for that reason Meisner (1840), according to Domke (1934), mistakenly considered them to be staminodes. These structures, in their original position according to Domke (1934), are inserted at the base of the calyx lobes and slightly higher than the insertion of the antipetalous stamens but through zygomorphy these structures have positioned themselves in a single whorl at the same height as, or sometimes below, the filament insertion. This situa-

tion is not met in other genera such as *Gnidia* and *Struthiola*, where the petal-like structures are inserted above the insertion of the filaments at the mouth of the tube. From the vascular anatomy of the flowers one would rather believe the converse, namely that the scales were originally positioned below the antipetalous stamen whorl and through zygomorphy have been slightly displaced to above the antisealous stamen insertion, as in *L. filamentos*. Heinig (1951) considered these structures to be stipules of the calyx lobes and found no reason to consider them to be vertical extensions of the disc as Gilg (1894)

did. Taxonomists have not been eager to accept the interpretation of the petaloid scales as stipules on the grounds that stipulate sepals would not occur in a group in which the foliage leaves are exstipulate. Heinig (1951) supported her interpretation on the grounds that the absence of stipules on the foliage leaves and the presence of stipular appendages in the floral organs should be considered another aspect of the progressive reduction from a more primitive state. Heads (1990) rejects Heinig's interpretation of the petaloid scales being stipules on the grounds that she used the concepts of 'leaf' and 'stipule' of Eames & MacDaniels (1948) which were in turn derived from Van Tieghem's (1871 in Heads 1990) morphology which he regards as being fundamentally flawed. Heads (1990) refers to the comparable organs in *Kelleria* as gland scales.

In *Cryptadenia*, as in *Lachnaea*, different views regarding the scales have been expressed. They have been referred to as glands, scales, glandular or scale-like receptacular effigurations, or petaloid scales. Although Domke (1934) referred to them as 'glands', he regarded them as petaloid scales homologous to those of *Lachnaea*. According to Domke (1934) the 'effigurations' in *L. axillaris*, *L. diosmoides* and *L. ericoides*, because of their position and shape, lead directly to those in *Cryptadenia* where these structures are nearly completely attached abaxially to the hypanthium.

Because of their position and anatomy, we regard these structures in both *Lachnaea* and *Cryptadenia*, as scales which are mere emergences of the adaxial wall of the hypanthium.

The position of the scales in both genera is usually below the insertion of the antipetalous stamens. In the more zygomorphic forms in *Lachnaea* and in one species of *Cryptadenia*, where they are in close juxtaposition to the stamens, they emerge between the insertion of the antipetalous and antisepalous stamens. The position of the scales in the upper portion of the hypanthium is variable in both genera. Those of *Lachnaea* are inserted at the mouth of the hypanthium to midway down the upper portion of the hypanthium, whereas those in *Cryptadenia* are inserted at the mouth of the hypanthium to three quarters of the way down the upper portion of the hypanthium. On the grounds of the position of the scales, a generic character used by Meisner (1840, 1857), no cutoff point can be made to separate the two genera as the displacement of the scales is gradual. In both genera the scales may be non-glandular or glandular. Another generic character which Domke (1934) used, was the attachment of the scales to the hypanthium. According to him the scales in *Lachnaea* are basally attached, whereas those in *Cryptadenia* are abaxially attached. In *L. axillaris* the cup-shaped and sigmoid basal part of the upper portion of the hypanthium gives the impression that the scales are basally attached. If however, the sigmoid curve is removed by extending the hypanthium upwards, the scales would in fact be abaxially attached and would correspond to the situation in the flower of *C. filicanlis*.

Gynoecium

The ovary in both genera is sessile, pseudomonocarpous (consisting of one expanded or fertile carpel and

one contracted or sterile carpel) and unilocular with a solitary anatropous ovule laterally attached near the top of the ovary. The style is always laterally attached to the ovary. The stigma is either brush-like or capitate in both genera but may also be conical in *Cryptadenia*.

Zygomorphy is expressed in both genera through the lateral placement of the style and the single locule.

Fruit

In both genera the fruit is an achene which is enclosed within the persistent base of the hypanthium. According to Domke (1934) the achene is, without exception, characteristic of the Thymelaeoideae and thus at the generic level the fruit is not of taxonomic importance.

Pollen morphology

The pollen grains of *Lachnaea* and *Cryptadenia* have the same basic morphology. Based on the sculpture of the supratectal structures two pollen grain types can be distinguished within *Lachnaea*, namely those with vestigial spinules at the base of the three main ridges and those without spinules. In *Cryptadenia* the supratectal structures are devoid of spinules at the base of the three main ridges and are thus similar to the latter pollen grain type of *Lachnaea*. Furthermore, in both genera, the lateral sides of the trihedral structures are striate and the basal sides are either straight or emarginate. The pollen grain size, following Radford *et al.* (1974), is medium to large in *Cryptadenia* and small to large in *Lachnaea*. This feature, therefore, also overlaps in the two genera.

Karyology

In most Thymelaeaceae the haploid chromosome number ($n = 9$) and the somatic chromosome number ($2n = 18$) have been observed (Nevling & Woodbury 1966 in Ornduff 1968). The following references are given in Moore 1973: Sharma & Sarkar 1967, 1968, Bjorkquist *et al.* 1969, Delay 1969, Gupta & Gillett 1969, Majovsky *et al.* 1970, Bhat *et al.* in Löve 1974. In Moore 1977: Kuzmanov 1973, Loeve & Kjellqvist 1974, Majovsky *et al.* 1974, Heads 1990). Polyploidy has been recorded in *Dapline* (Heads 1990), *Daphnopsis* (Nevling & Woodbury 1966 in Ornduff 1968), *Edgeworthia* Meisn. (Heads 1990), *Pimelea* Banks & Sol. (Heads 1990), and *Wikstroemia* Endl. (Gupta & Gillett 1969 in Moore 1973; Heads 1990).

The chromosome number of *Lasiosiphon eriocephalus* Decne., according to Subramanyan & Kamble in Löve 1967, is $n = 8$. The genus *Lasiosiphon* Fresen. was incorporated in the genus *Gnidia* for southern Africa (Dyer 1975). Although the above species is not indigenous to South Africa, it was the only chromosome number previously available for a genus of the Thymelaeaceae represented in South Africa.

The chromosome counts of $n = 9$ here reported for the species of both *Lachnaea* and *Cryptadenia*, are the first records for these two genera. The basic chromosome number of $\times = 9$ was recorded for most genera of the

TABLE 6.—Comparison of characters in *Lachnaea* and *Cryptadenia*

Character	<i>Lachnaea</i>	<i>Cryptadenia</i>
Habit	shrubs or shrublets multi- or single-stemmed at base, 0.15–2.0 m tall	shrublets multi- or single-stemmed at base, 0.12–0.8 m tall
Phyllotaxis	alternate or decussate	decussate
Flower	hermaphrodite, tetramerous	hermaphrodite, tetramerous
Hypanthium	circumscissile	circumscissile
Position of circumscision zone above base of hypanthium	1/5–4/5	1/5–4/5
Basal portion of hypanthium	ellipsoid, widely ellipsoid, ovoid, widely ovoid or obovoid	ovoid or ellipsoid
Upper portion of hypanthium	funnel-shaped, cylindrical, obconical, cup-shaped or cup-shaped with a sigmoid curve	funnel-shaped or cup-shaped
Stamens	4 + 4, exerted	4 + 4, exerted or semi-exserted
Stamen insertion	epipetalous to third of the way down upper portion of hypanthium	epipetalous to three quarters of the way down upper portion of hypanthium
Floral scales	8, non-glandular or glandular	8, non-glandular or glandular
Scale insertion	mouth of hypanthium to midway down upper portion of hypanthium	mouth of hypanthium to three quarters of the way down upper portion of hypanthium
Style	lateral	lateral
Stigma	brush-like or capitate	brush-like, capitate or conical
Fruit	dry, enclosed in persistent base of hypanthium	dry, enclosed in persistent base of hypanthium
Leaf anatomy	epistomatic, isobilateral or dorsiventral; or amphistomatic, isobilateral or almost centric	epistomatic, almost isobilateral or dorsiventral
Pollen grains	monads, globose, polyforate, 22–52 µm in diameter, tectate and supraornate	monads, globose, polyforate, 40–50 µm in diameter, tectate and supraornate
Sculpture of supratectal structures	vestigial spinules present or absent, lateral sides of trihedral structures striate	vestigial spinules absent, lateral sides of trihedral structures striate
Chromosome number	n = 9	n = 9

Thymelaeaceae and can therefore not be used to demarcate genera.

CONCLUSIONS

The Thymelaeaceae is a family in which it is difficult to find sound characters for generic delimitation. According to Peterson (1959), only a few characters can be used and they are of superficial significance. While revising the thymelaeaceous genera of the African continent, Peterson (1959) experienced difficulties with the classification. According to him these difficulties were not so much connected to the species concept but rather to the delimitation of genera which showed morphologically continuous characters which merged them into each other.

According to Baillon (1880), the only other worker who has discussed generic characters in the Thymelaeaceae, the following characters are generally of generic value:

- * the number of floral parts,
- * the point of insertion of the stamens and the dimension of their filaments which render them exerted or enclosed,
- * presence or absence of the scales in the throat of the hypanthium,
- * presence or absence of a disc at the base of the gynoeceum,
- * whether the base of the hypanthium is shed or persists growing around the ripe fruit, and
- * the arrangement of the inflorescence.

In evaluating the results obtained from the present multidisciplinary study, consideration was given to those characters which Baillon (1880) advocated as being of value at generic level as well as those used by Heads (1990) to illustrate the major differences between *Kelleria* Endl. and *Drapetes* Lam. The results of this multidisciplinary approach, as summarized in Table 6, illustrate the great similarity between *Lachnaea* and *Cryptadenia*. These also show that several characters within *Lachnaea* exhibit a variation range which includes the variation in *Cryptadenia*, and that in a few other characters the variation range is extended in *Cryptadenia*. No distinguishing characters of generic value were found to support the present demarcation of *Lachnaea* and *Cryptadenia*. Furthermore Beyers & Van der Walt (1994) concluded that the inflorescence morphology revealed no distinct differences between *Lachnaea* and *Cryptadenia*.

With the view of establishing natural genera, and on the basis of the findings of this multidisciplinary study, we support the viewpoint of Baillon (1880) that *Cryptadenia* should be included within *Lachnaea*. A detailed taxonomic treatment of *Lachnaea sensu lato* should now be undertaken.

ACKNOWLEDGEMENTS

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Studies in the Ericoideae (Ericaceae). XVI. Six new species of *Erica* from the Western Cape, South Africa.

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Keywords: *Erica*, taxonomy, new species, South Africa, Western Cape

ABSTRACT

Six new species of *Erica* L. from the mountains of the Western Cape are described: *E. alnea* E.G.H. Oliv., *E. hexensis* E.G.H. Oliv., *E. hispiduloides* E.G.H. Oliv. and *E. tarantulae* E.G.H. Oliv. from the inland areas centred on the Hex River Mountains; *E. hottentotica* E.G.H. Oliv. and *E. magistrati* E.G.H. Oliv. from the Hottentots Holland Mountains between Stellenbosch and Somerset West.

UITTREKSEL

Ses nuwe spesies van *Erica* L. van die berge van die Wes-Kaap word beskryf: *E. alnea* E.G.H. Oliv., *E. hexensis* E.G.H. Oliv., *E. hispiduloides* E.G.H. Oliv. en *E. tarantulae* E.G.H. Oliv. van die binnelandse streke gesentreer op the Hexrivierberge; *E. hottentotica* E.G.H. Oliv. en *E. magistrati* E.G.H. Oliv. van die Hottentots-Hollandberge tussen Stellenbosch en Somerset-Wes.

INTRODUCTION

During our investigations of 'incertae' material housed in herbaria, a number of new taxa have been encountered. Five small-flowered species that would currently be placed in the section *Arsace* and one in the section *Eurystoma*, according to *Flora capensis* (Guthrie & Bolus 1905), are dealt with in this paper. Most of the material has resulted from the remarkable collecting done by T.P. Stokoe and then Miss Elsie Esterhuysen on the high mountains of the Western Cape during the period from the 1930's to the 1980's.

1. *Erica hispiduloides* E.G.H. Oliv., sp. nov. (§ *Arsace*), *E. hispidulae* L. pervulgatae, *E. maestae* Bolus et *E. glandulipilae* Compton affinis sed ab *E. hispidula* pilis mollibus in ramulis foliis pedicellis et sepalis, ab *E. glandulipila* pilis longis eglandulosis vel glandulosis in ramulis, glandibus sessilibus in marginibus sepalorum, ab *E. maesta* bracteis bracteolisque subaequalibus saepe esulcatis et glande apicali distinguitur. Figura 1.

TYPE.—Western Cape, 3319 (Worcester): Worcester Div., Hex River Mtns, Milner Ridge Peak, cliffs on S side, 1 525–1 678 m. (–AD), 10–11–1943, *Esterhuysen* 9379 (BOL, holo.; PRE, STE).

Shrub erect, densely branched, 0.3–1.2 m tall. *Branches* puberulous and with very long soft gland-tipped, rarely eglandular hairs and shorter gland-tipped hairs intermixed, with no infrafoliar ridges, bark splitting irregularly. *Leaves* 3-nate, 2.0–3.0 × 0.6 mm, elliptic-

oblong, erect to spreading, subopen-backed with revolute rounded edges, puberulous, edged with a few very long stout gland-tipped hairs and one apically; petiole ± 0.5 mm long, ciliate. *Flowers* 3-nate at ends of short lateral branchlets, erect to spreading; pedicel 1–2 mm long, puberulous; bract submedian, 0.5–1.0 × 0.3–0.5 mm, narrowly elliptic, sulcate or occasionally esulcate, puberulous, with large apical gland; bracteoles opposite, median, similar to bract but slightly smaller. *Calyx* 4-lobed almost to base, 0.7–1.5 mm long, cyathiform, green to pink, lobes ovate, acute, sparsely puberulous, edged with large glands. *Corolla* 4-lobed, 1.5 × 2.0–2.5 mm, cyathiform-urceolate, glabrous, pink, occasionally creamy yellow, lobes erect, broadly rounded, about quarter length of corolla. *Stamens* 8 included; filaments ± 0.5 mm long, oblong, slightly broadening to base with sigmoid bend below anther, glabrous; anther erect, muticous, thecae oblong-elliptic, 0.4 × 0.8 mm, glabrous; pore half length of theca; pollen in tetrads. *Ovary* 4-locular, 4-lobed, 0.5 × 0.9 mm, obovoid and emarginate, sparsely pilose, with no basal nectary glands, ovules 15–20 per locule, spreading to pendulous on a subapical placenta; style 0.3–1.0 mm long, glabrous; stigma broadly cyathiform. *Capsule* depressed globose, 1.0 × 1.2 mm, glabrous, yellowish brown, septa free from central axis; seeds ellipsoid, ± 0.4 mm long, elongate reticulate, golden brown. Figure 1.

This species is distinguished by the short soft hairs on the stems, leaves, pedicel and sepals with long soft bending hairs, which may be glandular and eglandular, intermixed with them on the branches, by sessile glands edging the sepals and by the small subequal bract and bracteoles which have a terminal stalkless gland and are often devoid of a sulcus.

It is closely related to the very common and widespread *E. hispidula* L. which has a shiny rather than dull

* Stellenbosch Herbarium, National Botanical Institute, P.O. Box 471, Stellenbosch 7599.
MS. received: 1994-05-04.

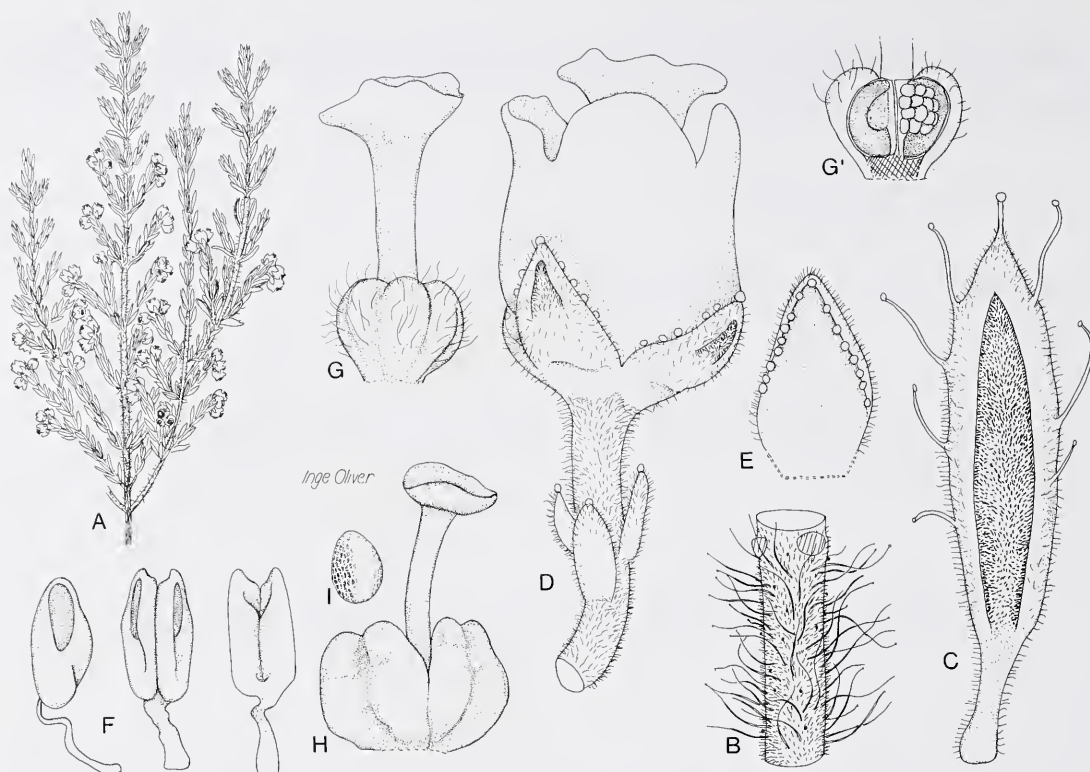


FIGURE 1.—*Erica hispiduloides*. A, flowering branches, $\times 1$; B, stem; C, leaf; D, flower; E, sepal; F, anther, side, front & back views; G, gynoecium; G', ovary cut longitudinally; H, fruiting gynoecium; I, seed. B, $\times 6$, C–I, $\times 25$. All drawn from type, Esterhuysen 9379.

appearance on close examination, stiffer, hispid hairs which are sparser than the dense puberulous hairs of the new species, particularly on the branches. *E. hispidula* has lanceolate glabrous cartilaginous sepals and the corolla is more urceolate with spreading lobes. It can also be distinguished from another species, *E. glandulipila* Compton, which has long gland-tipped hairs on the sepals, anther appendages and a peltate stigma. The other close relative, *E. maesta* Bolus, differs in having no sessile glands on the sepals, a glabrous ovary and plumose hairs on branches and leaves.

E. hispiduloides occurs at high altitudes on the mountains around the Worcester basin with an outlier to the north in the southern Cedarberg and an extension eastwards along the Klein and Great Swartberg as far as Blesberg (Figure 2). The species could well be more frequent, but may have been overlooked due to its close superficial resemblance to *E. hispidula* which is probably the commonest species of *Erica* in the Western Cape.

The habitat of the species is distinctive, being on moist rock ledges on cliffs or very steep gullies on the south

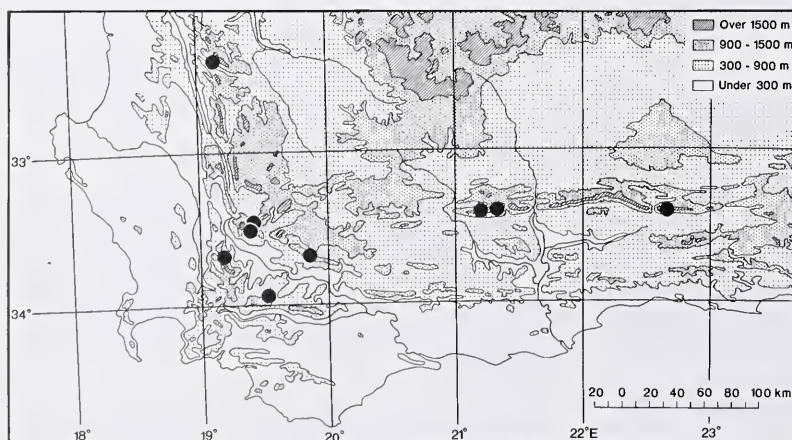


FIGURE 2.—The known distribution of *Erica hispiduloides*.

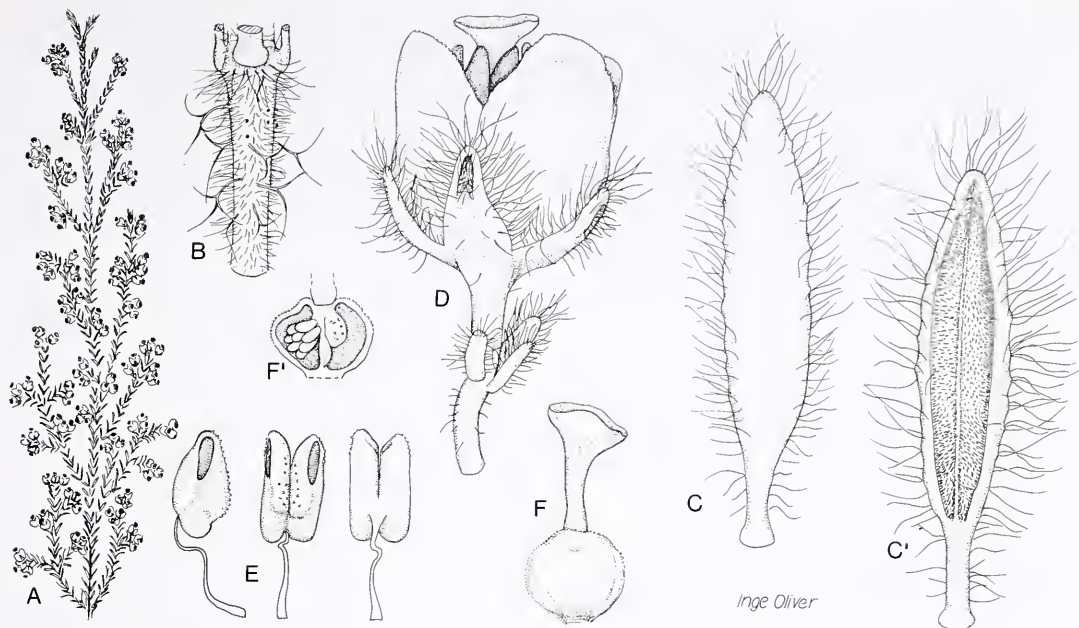


FIGURE 3.—*Erica hexensis*. A, flowering branch, $\times 1$; B, stem; C, leaf, adaxial view; C', abaxial view; D, flower; E, anther, side, front & back view; F, gynoeceum; F', ovary, cut longitudinally. B–F', $\times 25$. All drawn from Esterhuysen 8164.

side of mountains between 1 500 and 2100 m where it forms dense woody shrubs up to 1.2 m tall. On the ledges facing south on Jonaskop, the plants were not common and displayed two colour forms in the flowers on different plants—creamy yellow with a tinge of pink or pure bright pink. The latter were the taller shrubs, otherwise no differences could be found between the two forms. Flowers from September to December.

Specimens examined

WESTERN CAPE.—3219 (Wuppertal): Cedarberg, Uitkyk Peak, 1 495 m, (–AC), 12-10-1975, *Esterhuysen* 34008 (BOL, PRE); 3319 (Worcester): Hex River Mtns, Milner Ridge Peak, 1 520–1 680 m, (–AD), 10-11-1943, *Esterhuysen* 9379 (BOL, PRE, STE); Milner Peak, 1 830 m, (–AD), 11-11-1960, *Esterhuysen* 28610 (BOL, K, PRE); kloof between Milner Ridge Peak & Shale Peaks, 1 680 m, (–AD), 2-01-1961, *Esterhuysen* 28711 (BOL); Milner Peak, 1 680 m, (–AD), 11-10-1980, *Esterhuysen* 35525 (BOL); Du Toits Kloof, Molenaarsberg, 1 520 m, (–CA), 5-10-1947, *Esterhuysen* 14095 (BOL); Slanghoek Mtns, Witteberg, 1 830 m, (–CA), 28-10-1979, *Esterhuysen* 35269 (BOL, K); Brandwacht Peak, 1 830 m, (–CB), 26-11-1944, *Esterhuysen* 11022 (BOL); Chavonnesberg, 1 620 m, (–CB), 3-10-1948, *Esterhuysen* 14581 (BOL); Hex River Mtns, Horseshoe Peak, 1 680 m, (–CB), 1-11-1953, *Esterhuysen* 22205 (BOL); Fonteintjiesberg, Meiring's Plateau, 1 680 m, (–CB), 20-10-1963, *Esterhuysen* 30412 (BOL); Robertson Dist., Dasiesshoek Peak, 1 370 m, (–DB), 3-09-1961, *Esterhuysen* 29122 (BOL); Jonaskop, 1 616 m, (–DC), 04-1983, *Oliver* 7971 (STE); *Oliver* 7972 (STE); *ibid.*, 8-04-1994, *Oliver* & *Oliver* 10450 (BM, K, PRE, STE); top of Baviaanskloof in Boschjesveld Mtns, (–DC), 02-1940, *Stokoe* 7488 (BOL, PRE) & *SAM* 55109A (SAM). 3321 (Ladismith): Klein Swartberg, Toverkop, 1 980 m, (–AC), 16-12-1956, *Esterhuysen* 26760 (BOL, K); Klein Swartberg W of Seven Weeks Poort Mtn, ledges on S side of Ridge Peak, 2 100 m, (–AD), 27-12-1928, *Andreae* 1231 (BOL, PRE, STE); Klein Swartberg, main ridge W of Hocko Peak, 2 060 m, (–AD), 4-02-1992, *Oliver* 10015 (STE). 3322 (Oudtshoorn): Swartberg, Blesberg, 1 830 m, (–BC), 17-10-1955, *Esterhuysen* 24919 (BOL, K, PRE).

2. *Erica hexensis* E.G.H. Oliv., sp. nov., (§ *Arsace*), *E. hispidulae* L. et *E. glandulipilae* Compton affinis sed

pilis longis apicibus perlonge furcatis, glandibus sessilibus paucis in ramulis, aliter eglandulosa, antheris muticis, ovario papillato-verrucoso differt. Figura 3.

TYPE.—Western Cape, 3319 (Worcester): Ceres Dist., Hex River Mtns, shale band from Witels Kloof up to Bufelshoek Peak, SW aspect, 1 525–1 830 m, (–AD), 8-10-1956, *Esterhuysen* 26366 (BOL, holo.; K, NBG, STE).

Shrub erect, compact up to 1 m tall. Branches erect with numerous soft small lateral branchlets, puberulous, some hairs up to 0.2 mm long and with long stouter long-forked hairs up to 0.5 mm long and occasional sessile red glands intermixed, older branches with more forked hairs, with no infrafoliar ridges, bark grey, splitting irregularly when older. Leaves 3-nate, 2.0×0.5 mm, oblong-elliptic, open-backed, sparsely long villous mainly towards margins, abaxially shortly hispid; petiole ± 0.5 mm long, sparsely long ciliate. Flowers 3-nate at ends of very short lateral branchlets, mostly facing upwards; pedicel ± 1.4 mm long, glabrous or occasionally with a few short hairs; bract and bracteoles median 0.4 and 0.3 mm long respectively, oblong not sulcate, glabrous sparsely ciliate with long hairs. Calyx 4-lobed, fused at base only, lobes 0.8 mm long, lanceolate, acute, sulcate in upper half, half as long as corolla, ciliate with long thin hairs and with some scattered on abaxial side. Corolla 4-lobed, 1.5×1.4 mm, cyathiform, glabrous, dusky red to pink, lobes obtuse, crenate-fimbriate, erect. Stamens 8 included; filaments 0.7 mm long, narrowly linear from a slightly broader base with a subsigmoid bend below anther, glabrous; anther just manifest, 0.8×0.4 mm, ovate, obtuse, erect, dorsally attached near base, muticous, very shortly strigose on adaxial edge; pore one third to half length of theca; pollen in tetrads. Ovary 4-locular, 4-lobed, 0.6×0.6 mm, broadly ellipsoid and slightly emarginate, finely papillate, with no

nectary glands at base, ± 8 ovules per locule, subpendulous, placenta bulbous in upper half; style 0.5–1.0 mm long, slightly to much exerted, glabrous; stigma cyathiform, red. *Fruit* unknown. Figure 3.

E. hexensis is another of the small-flowered species in the section *Arsace* that bears a resemblance to the very common *E. hispidula*. From this it may be distinguished by the long soft hairs with long-forked tips on the branches, lack of glands except a few sessile ones on the branches, distinct white median line down the sepals, cyathiform corolla and papillate-verrucose ovary.

From the more eastern *E. glandulipila* it differs in the lack of glands and anther appendages, the ovary surface and the cyathiform stigma, the latter having a subpeltate-capitate stigma. The type of hairs on the branches and the ovary indumentum serve to distinguish it further from *E. hispiduloides*.

As the name suggests the distribution of this species is centred on the high peaks collectively known as the Hex River Mountains in the Worcester/Ceres Districts (Figure 4). It grows on southwest- to southeast-facing slopes which are cool and moist. Flowers from September to November.

Specimens examined

WESTERN CAPE.—3319 (Worcester): Worcester Dist., Hex River Mtns, shale band near Buffels Dome, 1 700 m, (–AD), 10.11.1943, *Esterhuysen 9370* (BOL, PRE); Worcester Dist., Hex River Mtns, Milner Ridge Peak, 1 650 m, (–AD), 10.11.1943, *Esterhuysen 9371* (BOL); Ceres Dist., Hex River Mtns, shale band from Witels Kloof up to Buffelshoek Peak, 1 525–1 830 m, (–AD), 8-10-1956, *Esterhuysen 26366* (BOL, K, NBG, PRE, STE); Worcester Dist., Hex River Mtns, slopes below Buffelshoek Peak at head of Sentinel Kloof, 1 670 m, (–AD), 19-09-1965, *Esterhuysen 31201* (BOL); Worcester Dist., Mostertshoek, S face, 300 m, (–AD), 12-09-1976, *Mostert s.n.* (BOL); Mostertshoek, left side of Donkerkloof, 1 060 m, (–AD), 17-09-1977, *Mostert s.n.* (BOL); Worcester Dist., Chavonnesberg, cliffs below summit, 1 525 m, (–CB), 3-10-1948, *Esterhuysen 14578* (BOL); *ibid.*, 1 220 m, 4-10-1942, *Esterhuysen 8164* (BOL, K, NBG, MO, PRE, STE) & *8165, 8166, 8167* (NBG); Worcester Dist., Fonteintjiesberg, 1 525 m, (–CB), 20-10-1963, *Esterhuysen 30409* (BOL).

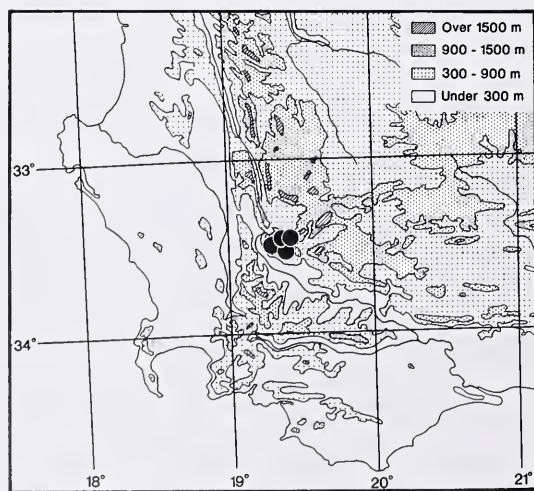


FIGURE 4.—The known distribution of *Erica hexensis*.

3. *Erica alnea* E.G.H. Oliv., sp. nov., (§ *Arsace*), *E. cupuliflorae* Dulfer affinis sed corolla late ellipsoidea, antheris muticis thecis adaxialiter setiferis, ovario glabro et stigmate late cyathiformi differt. Figura 5.

TYPE.—Western Cape, 3319 (Worcester): Ceres Dist., Hex River Mtns, shale band from Wit Els Kloof up to Buffelshoek Peak, SW aspect, steep banks above stream, 1 220 m, (–AD), 8-10-1956, *Esterhuysen 26362* (BOL, holo.; PRE, STE).

Shrub erect, to 600 mm tall, much branched, dense, lax and spreading in shady places. *Branches* hispidulous with no infrafoliar ridges, bark grey, flaking irregularly. *Leaves* 3-nate, appressed to spreading, reflexed in shaded plants, 2.0–2.5 \times 0.6 mm, linear-elliptic, flat adaxially with acute margins, convex and sulcate abaxially, glabrous and shortly ciliolate; petiole \pm 0.5 mm long, ciliolate, otherwise glabrous. *Flowers* 3 to 6-nate at ends of numerous short lateral branchlets; pedicel \pm 2 mm long, glabrous or with occasional short hairs at base; bract median to remote, \pm 0.5 mm long, oblong-lanceolate, slightly sulcate subapically, ciliolate; bracteoles opposite, just above bract and similar to bract. *Calyx* 4-lobed, fused in lower quarter, glabrous, lobes broadly ovate, subacute, glabrous, ciliolate, pink. *Corolla* 4-lobed, broadly ellipsoid, 2.0 \times 1.5 mm, glabrous, pink, lobes broadly rounded, erect to incurved, one third the length of corolla. *Stamens* 8 included; filaments \pm 0.5 mm long, oblong, almost straight, glabrous; anthers erect, muticous, glabrous, thecae ellipsoid, 0.8 \times 0.3 mm, with a few stiff hairs \pm 0.15 mm long on adaxial edges; pore two thirds the length of theca; pollen in tetrads. *Ovary* 4-locular, 8-lobed, globose and emarginate, 0.5 \times 0.7 mm, glabrous, no nectaries basally, ovules 20–26 per locule pendent from large complete placenta; style 0.5–1.0 mm long, glabrous, red; stigma cyathiform, manifest to well exerted, red. *Capsule* globose, 1.4 \times 1.0 mm, septa free from central axis; seeds 0.2 \times 0.1 mm, subovoid-ellipsoid, irregularly angled, the angles often sharp, shallowly reticulate, yellow to yellowish brown. Figure 5.

E. alnea is most closely related to *E. cupuliflora* on account of the bulbous joined base of the calyx but differs in having a broadly ellipsoid corolla, muticous anthers placed on short broad filaments and with short stout setae on the adaxial edges of the thecae, a glabrous ovary and far exerted cyathiform stigma. Dulfer's (1963) species has an open cyathiform flower, scabrid anthers with long awns, a sparsely pubescent ovary and subcapitate-cyathiform stigma which is included. He likened his species to *E. micrandra* Bolus but that species has remarkable small anther thecae with relatively large narrow crests, and also to *E. monantha* Compton which has aristate leaves and belongs to the *E. longipedunculata* Lodd. complex. The species could also be mistaken for *E. tenuis* Salisb. or *E. leptopus* Benth. which have the same general facies but simple stigmas.

All of the species mentioned above occur in the Ceres District. The close ally, *E. cupuliflora*, occurs on sandy flats and lower slopes, whereas the new species is confined to damp slopes, streamsides and ledges at higher altitudes from the Worcester/Ceres area with an outlier in the central Cedarberg to the north (Figure 6). The type

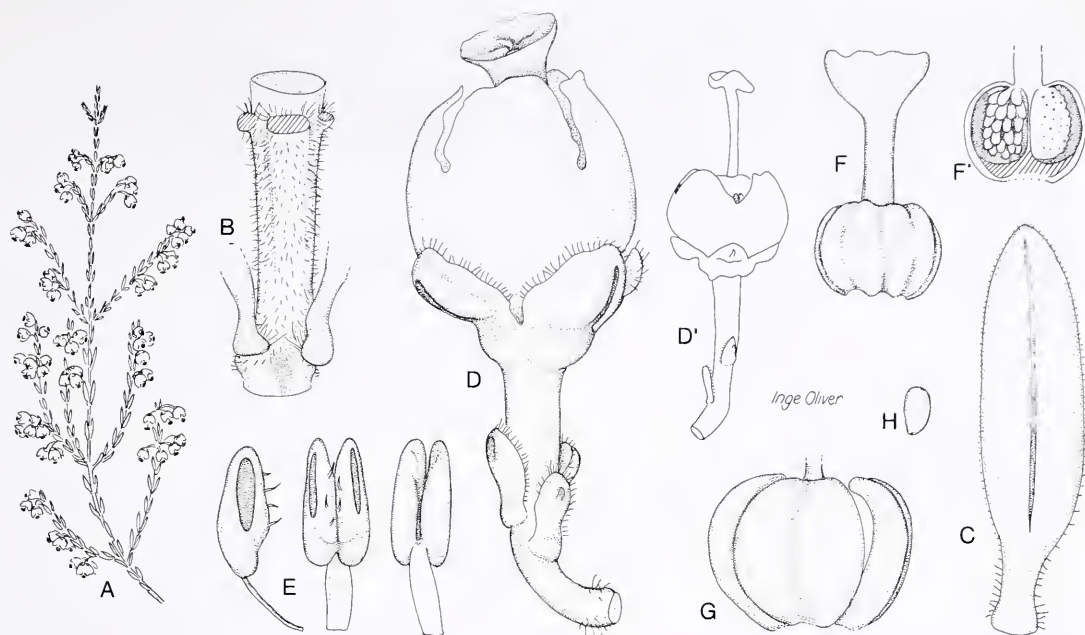


FIGURE 5.—*Erica alnea*. A, flowering branch, $\times 1$; B, stem; C, leaf; D, flower; D', old fruiting flower; E, anther, side, front & back views; F, gynoecium; F', ovary cut longitudinally; G, fruit; H, seed. B–H, $\times 25$, with D', $\times 12.5$. All drawn from type, Esterhuysen 26362.

collection comes from the Witels area, named after the white alder [witels], *Platylophus trifolius* (L.f.) D. Don (Cunoniaceae), hence the name of the new species. It was collected at the same time as the type of *E. hexensis* (q.v.). Flowers from May to October depending on the locality.

Specimens examined

WESTERN CAPE.—3219 (Wuppertal): Cedarberg, Sneeuwberg area, Cedarhout Kloof, 910 m, (–AC), 2-09-1963, Esterhuysen 30316 (BOL, K). 3319 (Worcester): Roodzand Pass, Tulbagh side, (–AA), 1-08-1938, Stokoe 6836 (BOL); Hex River Mtns. shale band from Witels Kloof up to Buffelshoek Peak, 1 220 m, (–AD), 8-10-1956, Esterhuysen 26362 (BOL, PRE, STE); Red Kloof at Worcester end of Du Toits Kloof, (–CA), 7-09-1958, Esterhuysen 27890 (BOL); Sanddrift Kloof, 910 m, (–BC), 29-05-1949, Esterhuysen 15402 (BOL, MO, NBG, PRE, STE); Prospect Peak, 1 070 m, (–BC), 2-10-1949, Esterhuysen 15914 (BOL); Outer Sanddrift Peaks, 1 220 m, (–BC), 28-10-1962, Esterhuysen 29752 (BOL, PRE); Audensberg, (–CB), 6-10-1940, Esterhuysen 3343 (BOL); Fonteinjiesberg, (–CB), 08/09-1925, Stokoe in BOL 18399 (BOL); Stettynsberg, (–CD), 07-1949, Stokoe in SAM 62334 (BOL, SAM); Louwshoek Mtn, (–CD), 11-1946, Stokoe in SAM 62341 (BOL, PRE, SAM).

4. *Erica tarantulae* E.G.H. Oliv., sp. nov., in genere distinctissima propter cristas antherarum perasymmetricas et saepe adscendentes sed in sectione *Eurystoma* posita, *E. calyciniae* L. et *E. brevicaulis* Guthrie & Bolus affinis sed ab eis pilis paucis simplicibus non dendroideis, stylo apicale papillato differt. Figura 7.

TYPE.—Western Cape, 3319 (Worcester): Cape, Ceres Dist., Waaihoek Mtns, peak E of Tarantula Peak, on small stony plateau, 1 200–1 370 m, (–AD), 7-10-1954, Esterhuysen 21829 (BOL, holo.; MO, K, PRE, STE).

Shrublets low, semi-sprawling up to 160 mm tall. Branches trigonous with no distinct infrafoliar ridges,

puberulous when young, soon becoming glabrous, bark splitting irregularly and with small infrafoliar flakes. Leaves 3-nate, erect, adpressed, $1.5\text{--}2.0 \times 0.8$ mm, narrowly ovate to elliptic, convex and sulcate abaxially with sharp edges, flat adaxially, puberulous towards base adaxially and sparsely ciliolate with hairs and a few stalked, red, gland-tipped hairs, otherwise glabrous; petiole ± 0.3 mm long, ciliolate, glabrous abaxially, puberulous adaxially. Flowers 3–6 at ends of main and short lateral branchlets, mostly pendulous; pedicel ± 0.3 mm long, glabrous; bract approximate, 1.3×1.0 mm.

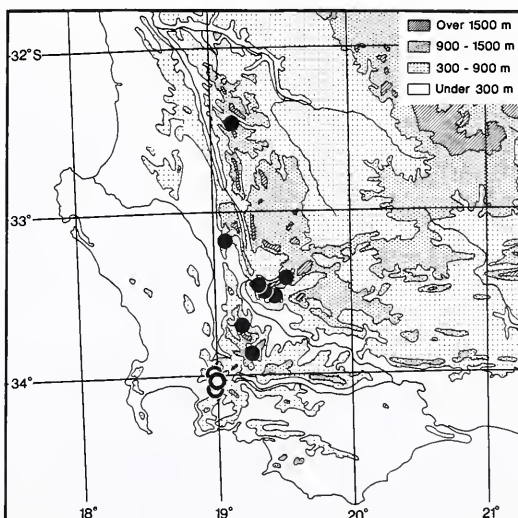


FIGURE 6.—The known distribution of *Erica alnea*, ●, and *E. hottentotica*, ○.

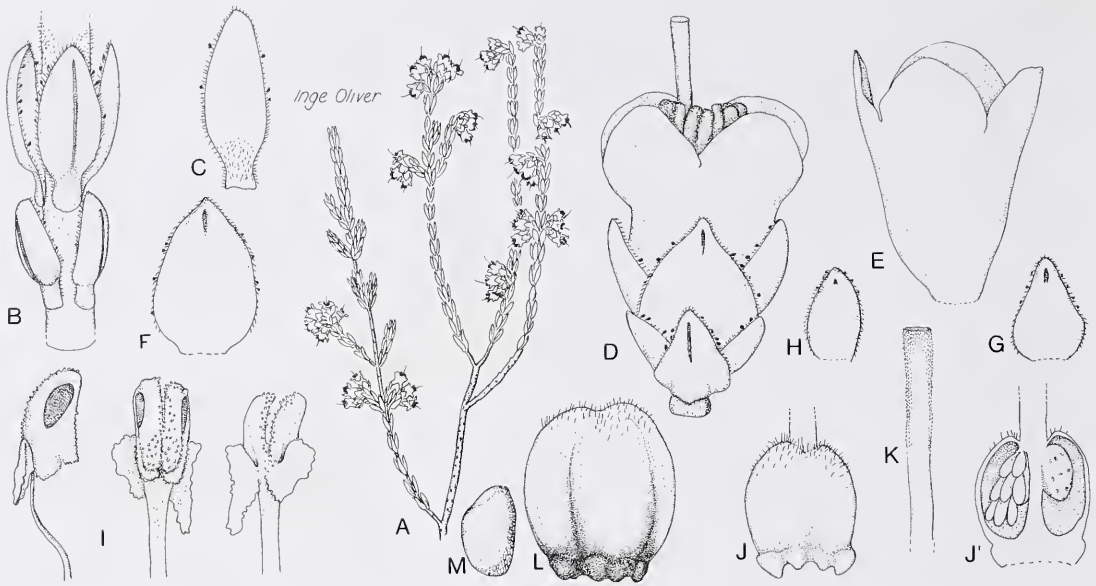


FIGURE 7.—*Erica tarantulae*. A, branch, $\times 1$; B, stem & leaves; C, leaf, adaxial view; D, flower; E, corolla; F, sepal; G, bract; H, bracteole; I, anther, side, front & back views; J, ovary; J', ovary, cut in half longitudinally; K, style & stigma; L, fruit; M, seed. B–H, $\times 12.5$; I–M, $\times 25$; L, drawn from *Stokoe* 7889; rest drawn from type, *Esterhuysen* 21829.

broadly ovate, sulcate in upper half, glabrous, ciliate with hairs and stalked red glands, rose pink; bracteoles approximate, like bract, but 1.2×0.8 mm. *Calyx* 4-partite, segments 2.0×1.3 mm, elliptic to ovate, shortly sulcate apically, glabrous, ciliate with hairs and some stalked red glands, rose pink. *Corolla* 4-lobed, 4.5×2.5 mm, obconical, glabrous, rose pink, lobes quarter the length of corolla, broadly obtuse, erect to slightly spreading. *Stamens* 8, included to manifest; filaments ± 2 mm long, linear, slightly bent backwards below anther; anthers dorsally attached near base, appendiculate, thecae ± 0.7 mm long, oblong-falcate, obtuse, roughly papillate, crests very variable in shape and size even on same anther, large,

fleshy, variously serrate, sometimes erect, pore half the length of theca; pollen in tetrads. *Ovary* 4-locular and 4-lobed, 1.0×0.8 mm, broadly ellipsoid and emarginate, sparsely puberulous apically, with nectary glands basally, 6–8 ovules per locule, pendulous on subglobose placenta in upper half; style ± 4 mm long, narrow cylindrical, exerted, papillate apically; stigma simple to subpellate. *Capsule* ellipsoid, 1.3×0.8 mm, reddish brown with much darker base, valves splitting to base, septa almost free from axis; seeds 0.5–0.6 mm long, subtrigonus-ellipsoid, yellowish brown, finely and closely reticulate, reticulations tangentially finely undulate. Figure 7.

This very distinct species is unique in the genus for the form of the anther appendages which are broad, very irregularly shaped crests which, in some anthers, may be absent on one side (Figure 7I). They are remarkable in sometimes being larger above the point of attachment to the theca and therefore totally ascending.

The superficial facies of the calycine, open-mouthed flowers with manifest stamens would place the species in the section *Eurystoma* of *Flora capensis* (Guthrie & Bolus 1905) where it shows some resemblance to several species which occur in the same area: *E. calycina*, *E. brevicaulis* and *E. costatisepala* H.A. Baker. These latter species have complex dendroid hairs on many parts of the plant and have long pedicels. *E. tarantulae* has a sparse complement of short fine simple hairs and almost sessile flowers. The style is also unusual in being apically papillate, a condition found only in the section *Platyspora*.

E. tarantulae appears to be very restricted in its distribution, being known only in the Hex River Mountains complex as two localized collections from Tarantula and Milner Peaks (Figure 8). It is recorded as growing on stony ground where it forms low, spreading shrublets. Flowers from early August to late in October.

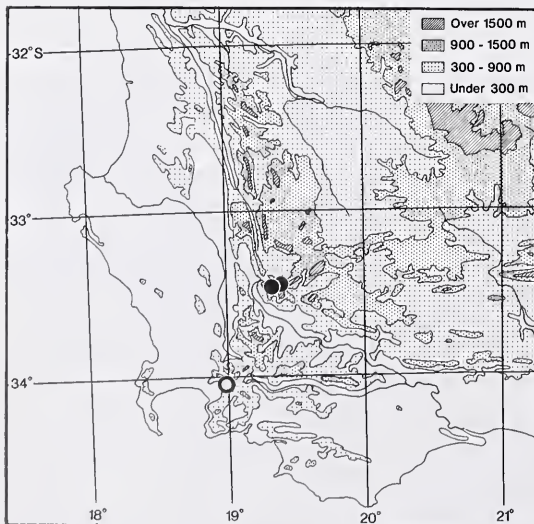


FIGURE 8.—The known distribution of *Erica tarantulae*, ●, and *E. magistrati*, ○.

Specimens examined

WESTERN CAPE.—3319 (Worcester); Ceres Dist., peak E of Taran-tula Peak, stony plateau, 1 200–1 370 m, (–AD), 7–10–1953, *Esterhuysen* 21829 (BOL., K, MO, PRE, STE); Ceres Dist., Hex River Mtns, Ezelsfontein, stony N slopes of Milner Peak, 900 m, (–AD), 24–08–1958, *Esterhuysen* 27859 (BOL.). Without locality: *Stokoe* 7889 (BOL.).

5. *Erica hottentotica* E.G.H. Oliv., sp. nov. (§ *Ephebus*), *E. parviflorae* L. affinis sed sepalis ovatis petaloideis roseis, corolla puberula, stigmathe cyathiformi differt. Figure 9.

TYPE.—Western Cape, 3418 (Simonstown); Somerset West area, Hottentots-Holland Mtns, Somerset Sneeuwkop, (–BB), *Stokoe* 6641 (BOL., holo.; K, PRE, STE).

Erect compact shrub 0.5–1.0 m, rarely up to 2.5 m, tall. *Branches* erect, leafy with numerous dense lateral short shoots, softly puberulous, without infrafoliar ridges, bark flaking irregularly when old. *Leaves* 4-nate, erect, imbricate, 0.5–3.5 mm long, oblong-elliptic, subobtuse, flattened adaxially with a distinct sharp margin, convex and sulcate abaxially, with a few scattered short hairs mainly towards margins abaxially, adaxially hairy; petiole ± 0.5 mm long, sparsely ciliolate. *Flowers* 1- to 4-nate terminal on short lateral branchlets, upright to pendent; pedicel ± 2.0 mm long, puberulous; bract remote to median, 0.6×0.2 mm, oblong, not sulcate, sparsely puberulous; bracteoles 2, median, same as bract. *Calyx* 4-partite; segments 1.4×0.8 mm, ovate to lanceolate, slightly sulcate apically, puberulous, pink. *Corolla* 4-lobed, 3.0×2.0 mm, cyathiform to urceolate, puberulous, red, lobes ± 0.5 mm long, rounded erect or slightly reflexed. *Stamens* 8, included; filaments ± 1.5 mm long, filiform, with sigmoid bend just below anther, glabrous; anther dorsally attached near base, appendiculate, thecae 1.0×0.3 mm, oblong with acute apex, sparsely puberulous laterally and adaxially mainly towards base.

awns ± 0.4 mm long, sparsely puberulous, pore half length of theca. *Ovary* 4-locular, 0.5×0.7 mm, oblate to obovate, slightly 8-lobed, emarginate, with basal nectary glands, with a few longish hairs apically, ± 4 slightly erect ovules per locule; style ± 4.0 mm long, glabrous, just exserted; stigma cyathiform with 4 apical stigmatic papillae. Fruit unknown. Figure 9.

This species is closely related to the common and widespread *E. parviflora* but can easily be distinguished by its broader, ovate, petaloid, pink sepals, finely hairy corolla and broad cyathiform stigma. The latter species has linear-lanceolate foliaceous sepals, a coarsely long-haired corolla and a small capitate stigma. The flowers of *E. hottentotica* are larger than those of *E. parviflora* although the form of the latter in the Hottentots Holland Mountains has fairly large flowers. *E. parviflora* is generally a scrambling plant in marshes, whereas the new species appears to form an erect sturdy shrub which may reach a height of 2.5 m (*Stokoe* 4009). There is also a resemblance to some forms of the common *E. sitiens* Klotzsch which has, however, a glabrous corolla, foliaceous sepals and a capitate stigma.

This species is confined to the higher reaches of the Hottentots-Holland Mountains above Somerset West, hence the name (Figure 6). It has been recorded with the following species, *E. magistrati*, on Langkloofberg frequenting similar habitats—moist southeast-facing slopes. The Hottentots-Holland Mountains host the largest number of species of *Erica*: 175 spp. have been recorded so far (Oliver *et al.* 1983). Flowers from September to late November.

Specimens examined

WESTERN CAPE.—3418 (Simonstown); Somerset West area, Hottentots Holland Mtns, (–BB); Langkloofberg, 1 220 m, (–BB), 30–10–1943, *Esterhuysen* 9150 (BOL., STE); The Triplets, 1 220–1 520 m, (–BB), 31–10–1943, *Esterhuysen* 9173 (BOL.); Klein Valleiberg, 1 070–1 220 m, (–BB), 11–10–1962, *Esterhuysen* 29868 (BOL., K, PRE);

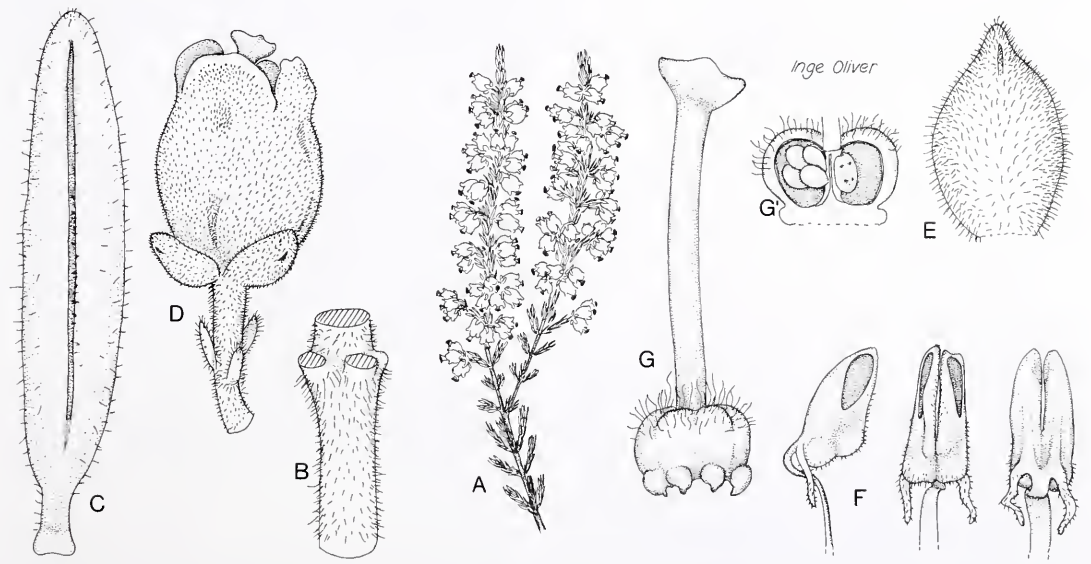


FIGURE 9.—*Erica hottentotica*. A, flowering branch, $\times 1$; B, stem; C, leaf; D, flower; E, sepal; F, anther, side, front & back views; G, gynoecium; G', ovary, cut longitudinally. B–E, $\times 12.5$, F, G & G', $\times 25$. All drawn from *Esterhuysen* 9150.

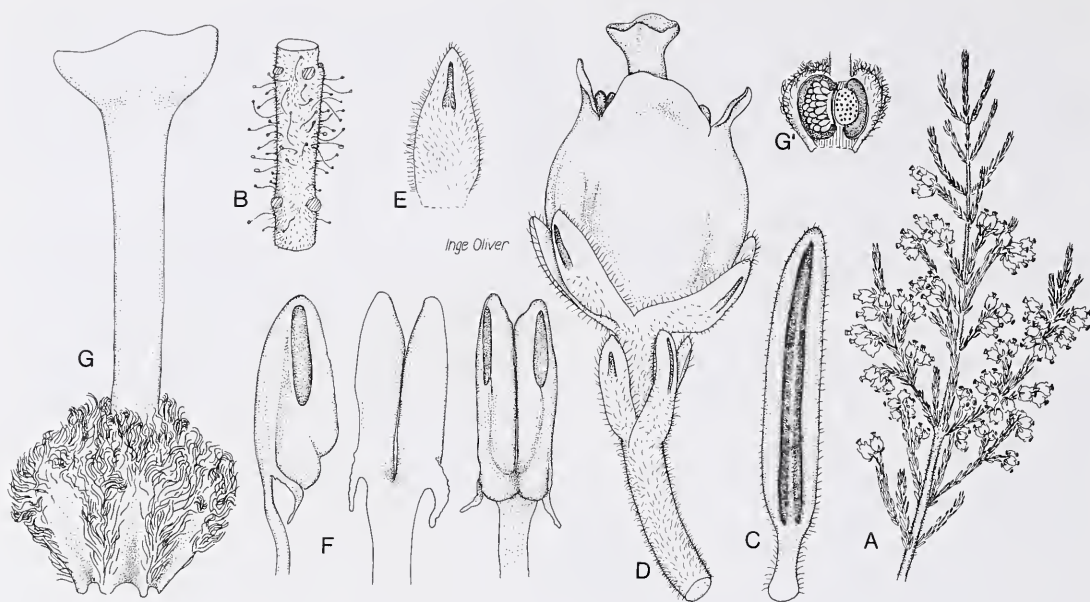


FIGURE 10.—*Erica magistrati*. A, flowering branch, $\times 1$; B, stem; C, leaf; D, flower; E, sepal; F, anther, side, back & front views; G, gynoceium; G', ovary, cut longitudinally. B–G', $\times 25$. All drawn from Esterhuysen 33921.

Landdrost Kop, 910–1 070 m, (–BB), 30-09-1979, *Esterhuysen* 35249 (BOL, K); vicinity of Landdrost Kop & Somerset Sneekop, (–BB), 11-1934, *Stokoe* 4026 (BOL, PRE); Somerset Sneekop, (–BB), 11-1938, *Stokoe* 6641 (BOL, K, PRE, STE); *ibid.*, *Stokoe* 6826 (BOL); between Somerset Sneekop & Landdrost Kop, (–BB), 26-09-1943, *Stokoe* 8927 (BOL).

6. *Erica magistrati* E.G.H. Oliv., sp. nov. (§ *Arsace*), *E. salaci* Salisb. affinis sed ab ea ramis ramulusque pilis multis brevissimis et longis glandulosis tectis, foliis pilis simplicibus, corolla urceolatiore et ovario villosio differt. Figura 10.

TYPE.—Western Cape, 3418 (Simonstown): Caledon Div., Hottentots-Holland, Langkloofberg, SE slopes near water, 910–1 220 m, (–BB), 30-10-1943, *Esterhuysen* 9145 (BOL, holo.; PRE, STE).

Erect woody shrub 0.6–1.8 m tall. *Branches* densely puberulous, the older with many long spreading stouter gland-tipped hairs intermixed, without infrafoliar ridges, bark splitting irregularly with age. *Leaves* 3-nate, imbricate to spreading, 4.0×0.8 mm, oblong-elliptic, elliptic in section with rounded margins, slightly open-backed, apex subacute sometimes the younger ending in a long gland-tipped hair, the younger pubescent with adpressed hairs, becoming glabrous abaxially, with scattered short hairs, marginally rarely also with long stouter gland-tipped hairs; petiole ± 0.8 mm long, ciliolate. *Flowers* mainly 3-nate, terminal on short lateral branchlets 0.5–10.0 mm long, erect to slightly spreading; pedicel ± 3 mm long, softly puberulous; bract median to approximate, lanceolate, 2.0×0.6 mm, sulcate in upper half, puberulous, white; bracteoles opposite, just above the bract, like bract but smaller. *Calyx* 4-lobed very slightly fused at base, lobes 2.0×0.6 mm, ovate, acute, sulcate in upper third, puberulous and ciliolate, white. *Corolla* 4-lobed, 3.0×2.5

mm, urceolate to cyathiform, glabrous or very rarely with a few short hairs, lobes ± 0.5 mm long, rounded, erect to slightly reflexed. *Stamens* 8 included; filaments filiform, 2.5×0.5 mm, erect, subsigmoid below anther, glabrous; anthers erect, placed just above ovary, dorsally attached near base, appendiculate, thecae 2.5 mm long, narrowly ovate-oblong, glabrous, crests ± 0.6 mm long, slightly serrate, attached at top of filament, pore half length of theca; pollen in tetrads. *Ovary* 4-locular, 8-lobed, broadly obovate, emarginate, 2.2×2.2 mm, villous mainly in upper half and in lower half along lobe edges, with no nectary glands at base, 15–20 ovules per locule spreading from a rounded central placenta; style ± 2.5 mm long, straight, glabrous, exserted; stigma cyathiform with 4 central stigmatic papillae, glabrous. *Fruit* unknown. Figure 10.

This species in the section *Arsace* is allied to *E. salax* Salisb. which has been collected only a few times in the same area. The latter has no long gland-tipped hairs on the branches, but has very short dendroid or gland-tipped marginal hairs on the leaves, a more cyathiform corolla and glabrous ovary. We have been able to examine Salisbury's type (*Masson s.n.*, Herb. Salisb. in Kew) to verify the correct identity of the few collections which were tentatively identified as this species.

There are also slight resemblances to *E. sphaeroidea* Duffer and *E. argyrea* Guthrie & Bolus from the same area, but these have puberulous corollas and numerous gland-tipped hairs on various other parts of the plant in addition.

E. magistrati is confined to the mountains in the Stellenbosch/Somerset-West area (Figure 8) where it is found mainly on south-facing slopes from 450 m to 1 068 m in situations receiving extra moisture. Several collections are

associated with Landdrostkop (Magistrate's Head) in the Hottentots-Holland range, hence the name of the species. Here there is often a good deposition of moisture from the dense moving clouds produced by the strong southeast winds which occur frequently during the summer months. Flowers from August to December.

Specimens examined

WESTERN CAPE.—3318 (Cape Town): Stellenbosch Dist., Jonkershoek, Langrivier, 760 m, (–DD), 08-1965, *Kerfoot* 5392 (PRE, STE). 3418 (Simonstown): Hottentots-Holland Mtns, Langkloofberg, 910–1 220 m, (–BB), 30-10-1943, *Esterhuysen* 9145 (BOL, PRE, STE); Landdrost Pinnacle above Lourensford, 460 m, (–BB), 7-09-1975, *Esterhuysen* 33921 (BOL, K, PRE, STE); Jonkershoek, beyond Second Waterfall, 1 220–1 520 m, (–?BB), 11-1925, *Krige in STE* 2130 (BOL); Somerset

Sneeuwkop, Landdrost Kop & environs, (–BB), *Stokoe* 6826 (BOL); *ibid.*, 11-1938, *Stokoe* 6827 (BOL, SAM); Landdrost Kop, (–BB), 26-09-1943, *Stokoe* 8933 (BOL, K, PRE). 3419 (Caledon): Jonkershoek, ridge between Eerste River Kloof and Victoria Peak, 1 070 m, (–AA), 7-09-1979, *Esterhuysen* 35242 (BOL, K).

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Notes on African plants

VARIOUS AUTHORS

ASPHODELACEAE/ALOACEAE

TYPIFICATION OF *ALOE* SPECIES DESCRIBED BY B.H. GROENEWALD

In the mid- to late 1930's, B.H. Groenewald (1935, 1936a–e, 1937a–c, 1938a–c, 1939, 1940) published a number of descriptions of new species and one new variety of *Aloe* L. Some of these were not accompanied by any indication of specimens examined, whereas others had specimen citations of the form 'Herbarium No. ***'. Localities and flowering times were given only in the discussion, and the name of the collector of cited specimens was uniformly omitted, as was any indication of where the 'type' might be found. It should be noted that only on or after 1 January 1958 did the indication of a holotype become compulsory in order to effect the valid publication of the name of a new taxon of the rank of genus or below (Greuter *et al.* 1988), thus about 20 years after Groenewald's major written contributions to alooid taxonomy. Furthermore, typification of extant yet untypified names is not compulsory (Greuter *et al.* 1988, Art. 7.4 '.... a lectotype or, a neotype may be designated ...', but see Art. 53.1), but in a taxonomically difficult genus such as *Aloe* it is essential in order to establish the correct application of the plethora of available names. In this paper we present the results of our attempts to formally establish types for the *Aloe* species published by Groenewald. Unfortunately very little is known about Groenewald in general and his taxonomic and cytogenetic research activities in particular, and he has been omitted from Gunn & Codd (1981). Coincidentally another southern African student of alooid taxonomy and cytogenetics, at about the same time, Dr Franz Sebastian Müller (1945), has also not been taken up in Gunn & Codd's (1981) benchmark biographical publication, the reason probably being that neither of them collected a sufficient number of specimens to warrant their inclusion. This situation will be rectified in the second edition of this book which is currently in preparation. One logical deduction from the way in which Groenewald cited specimens in his papers is that his 'types' were housed in a personal herbarium. However, evidence presented below indicates that such an herbarium never existed.

An extensive and detailed search for a personal herbarium belonging to Groenewald among his associates and descendants failed to produce any results. This search included the PRE and BLFU herbaria, the former as being the most likely institute to have inherited any private herbarium he made, and the latter as being closest to the place of publication of his new species and of his book on *Aloe* (Groenewald 1941). Not only were no specimens forthcoming, but no source questioned had any recollection of there ever having been a Groenewald private herbarium.

Positive evidence for the non-existence of a Groenewald private herbarium is largely indirect, and rests on four points: 1, for each name published by Groenewald except four, there is one (and usually only one) specimen in PRE, collected by Dr Frederick Ziervogel van der Merwe from the precise locality at the appropriate time indicated by Groenewald in the protologue, some of which are marked 'TIPE' in Van der Merwe's handwriting. As indicated below, most of these specimens are cited by Reynolds (1950) as 'Types'; 2, about half of these specimens have collector's numbers. Where a collector's number has been assigned it corresponds with the number (if any) given by Groenewald; 3, Groenewald and Van der Merwe worked closely together; all the illustrations published with Groenewald's papers are initialled by Van der Merwe, who is acknowledged first as having 'encouraged me in this work and greatly assisted' in Groenewald's (1941) book on aloes, and who is often credited with having found the plants Groenewald described. The $\pm 2\ 500$ specimens that Van der Merwe collected are all housed in PRE, and not in a private herbarium (Gunn & Codd 1981); 4, Gunn & Codd (1981) assert positively that Van der Merwe gave Groenewald 'several new species of *Aloe* ... for description'. This is supported by Dr R.A. Dyer (pers. comm.), who supplied much background information. The crux of this information is that, for whatever reason, Van der Merwe, as a medical inspector of schools, did not want to be seen to be describing new species of *Aloe*. He therefore passed his specimens on to Groenewald, who published the new species under his own name. Van der Merwe did, however, after his retirement describe a number of new species in the bulbous genera *Scilla* L. and *Resnova* Van der Merwe. All his *Scilla* species have since been transferred to *Ledebouria* Roth and *Resnova* is currently included in the synonymy of *Drimiopsis* Lindl. (Reid 1993).

Among Reynolds's notes used in the preparation of his book on South African aloes (Reynolds 1950) is the statement '*A. nubigena* v.d. Merwe or Groenewald m/s', indicating that these two worked so closely together that there is some doubt as to who contributed which part to any publication signed by either of them. It seems from correspondence preserved in these notes that Van der Merwe was on good terms with both Reynolds and Groenewald. A letter in Van der Merwe's handwriting records the gift of some plants of '*A. labiaflava* Groenewald' (= *A. greatheadii* Schönland var. *davyana* (Schönland) Glen & D.S. Hardy) to Reynolds shortly after the name was published by Groenewald. In his notes on *A. branddraaiensis*, Reynolds records 'Mr Groenewald has this species in hand, these notes are merely for my own records, and from the plant Dr Van der Merwe gave me'.

A note under *A. vryheidensis* indicates that the flow of information was not only from Van der Merwe to Reynolds: 'I gave Dr Van der Merwe a complete set of photographs, and informed him that there were thousands of the species growing ...'. This species was published in April 1937, but Reynolds's first note on it is dated July 1936. However, it is noteworthy that Reynolds (1950: 67) did not separately discuss Groenewald's contribution to alooid taxonomy in the historical section of his book, but mentioned him under '1935–1940. Dr F.Z. van der Merwe' only.

There is no evidence of any direct correspondence between Reynolds and Groenewald in this archival album. As there are very few complete letters in it, this does not preclude their having been such a correspondence. The only mention of any specimens is in a note on *A. branddraaiensis*, where Reynolds records having made a specimen from his plant for PRE, with permission from Groenewald and Van der Merwe. Although some Van der Merwe registers are housed at PRE, all of these deal exclusively with *Scilla*, and none contains an entry with a number as low as those discussed below. Tölken (1971) gives no indication of the whereabouts of any register of either Groenewald or F.Z. van der Merwe.

In our opinion it is therefore reasonable to accept that Groenewald never had a private herbarium and that the original material of the *Aloe* species which he described is deposited in PRE. The F.Z. van der Merwe collections in PRE bearing the same collection number as that cited in the protologue are considered to be holotypes, if only one number was cited. In cases where more than one specimen is quoted in the protologue or where the F.Z. van der Merwe specimen from the type locality does not bear a collecting number, lectotypes are chosen. Neotypes were selected where no types are cited in the protologue.

Groenewald described new species of *Aloe* in one of two journals only. The names affected are listed alphabetically by journal title:

Tydskrif vir Wetenskap en Kuns

A. decurvidens Groenew. (1937a): specimen cited 'Herbarium No. 107'. A *Van der Merwe* 107 specimen could not be found in PRE. Full citation: Neotype: Transvaal, Sabie River, Skukuza, *F.Z. van der Merwe s.n. in PRE* 24092 (PRE!); here designated. The specimen occupies two sheets; both are needed to confirm the identity of this plant. This name is considered to be a synonym of *A. zebrina* Baker.

A. dolomitica Groenew. (1938a): specimen cited 'Herbarium No. 235'. Full citation: Holotype: Transvaal, Strydpoort Mountains, *F.Z. van der Merwe* 235 (PRE!). The specimen occupies two sheets; both are needed to confirm the identity of this plant. This name is considered to be a synonym of *A. vryheidensis* Groenew.

A. graciliflora Groenew. (1936a): specimen cited 'Herbarium No. 77'. A *Van der Merwe* 77 specimen could not be found in PRE. Full citation: Neotype: Transvaal, Dullstroom, *F.Z. van der Merwe s.n. in PRE* 24089 (PRE!); here designated. The specimen occupies two

sheets, both of which are needed to confirm the identity of this plant. This name is considered to be a synonym of *A. greatheadii* var. *davyana*.

A. hlangapies Groenew. (1936b): specimens cited 'Herbarium No. 102, 103'. Full citation: Lectotype: Transvaal, Piet Retief Dist., Langgewacht, *F.Z. van der Merwe* 102 (PRE!); here designated. This name is considered to be a synonym of *A. ecklonis* Salm-Dyck. The specimen *F.Z. van der Merwe* 103 is also in PRE, and both these Van der Merwe specimens are of equal quality. No. 102 is marked 'TIPE' (Eng. TYPE) in F.Z. van der Merwe's handwriting, and 103 is marked 'tweede tipe' (Eng. second type—a meaningless designation) in the same hand.

A. labiaflava Groenew. (1936c): no specimen cited. Neotype: Transvaal, Gembokspruit, *F.Z. van der Merwe* 100 (PRE!); here designated. This sheet is marked 'TIPE' (Eng. TYPE) in F.Z. van der Merwe's handwriting. This name is considered to be a synonym of *A. greatheadii* var. *davyana*.

A. lusitanica Groenew. (1937b): specimen cited 'Herbarium No. 79'. Full citation: Neotype: Mozambique, Maputo, (Lourenço Marques), *F.Z. van der Merwe s.n. in PRE* 24087 (PRE!). The specimen occupies two sheets, both of which are needed to identify the plant. This name has long been shown to be synonymous with *A. komatiensis* Reynolds (1950), which is itself considered to be a synonym of *A. parvibracteata* Schönland.

A. nubigena Groenew. (1936d): specimen cited 'Herbarium No. 133'. Full citation: Holotype: Transvaal, Graskop, *F.Z. van der Merwe* 133 (PRE!). This is a good species.

A. recurvifolia Groenew. (1935): no specimen cited. Full citation: Neotype: Transvaal, Kappiekoppie near Graskop, *F.Z. van der Merwe* 73 (PRE!). Designated by Reynolds (1950). Van Druten (1956) showed conclusively that this name is a synonym of *A. alooides* (Bolos) Druten. In the protologue Groenewald's initials are incorrectly given as 'B.A.'

A. thompsoniae Groenew. (1936e): no specimen cited, but this is a good species. Dealt with elsewhere (Glen & Smith 1995).

A. vryheidensis Groenew. (1937c): specimen cited 'Herbarium No. 266'. Full citation: Holotype: Natal, Heine near Vryheid, *F.Z. van der Merwe* 266 (PRE!). This is a good species.

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It is noteworthy that no problems arose as far as specimen citation is concerned in the papers of Groenewald that were published in this botanical journal, which had a botanist as scientific editor (Dr I.B. Pole Evans for Vol. 18 and Dr E.P. Phillips for Vol. 20). Types were clearly stated and are cited below as they were included in the protologues. The following names are therefore listed here simply for completeness.

Aloe angustifolia Groenew.: in *The Flowering Plants of South Africa* 18: t. 708 (1938c). Holotype: Transvaal, Leydsdorp Dist., near Gravelotte, April 1936, F.Z. van der Merwe in *National Herbarium, Pretoria, No. 21,288* (PRE!). This name is invalidated by the earlier use of it by Haworth (1819: 47) and Salm-Dyck (1849). *A. angustifolia* Haw. is a synonym of *A. africana* Mill., and the same combination as used by Salm-Dyck probably belongs under *Gasteria disticha* (L.) Haw. (Stearn 1938; Van Jaarsveld 1992). This species has consequently been renamed *A. vandermerwei*, in honour of Dr F.Z. van der Merwe (Reynolds 1950). A critical taxonomic treatment of *Aloe* will show that the species should be included in the synonymy of *A. zebrina*.

Aloe branddraaiensis Groenew.: in *The Flowering Plants of South Africa* 20: t. 761 (1940). Holotype: Lydenburg Dist.; Branddraai, Van der Merwe (probably F.Z. van der Merwe) in *National Herb. 24208* (typus) (PRE!). The specimen occupies three sheets, all of which are needed to confirm the identity of this plant. In addition to the type two further PRE specimens, Van der Merwe 138 and Reynolds 2490 (!) are cited in the protologue. No specimen with the number Van der Merwe 138 was found at PRE; however there are three unnumbered specimens collected by F.Z. van der Merwe in this collection, PRE 22998, 38002, 38003. The specimen PRE 38002 is marked 'figured for FPSA by B. Connell July '39'. This is a good species.

Aloe davyana Schönland var. *subolifera* Groenew.: in *The Flowering Plants of South Africa* 19: 732 (1939). Holotype: Pretoria Dist., near Pienaars River, Aug. 1936, Van der Merwe (probably F.Z. van der Merwe) in *Nat. Herb. 22816* (PRE!). This name is considered to be a synonym of *A. greathedii* var. *davyana*.

Aloe lutescens Groenew.: in *The Flowering Plants of South Africa* 18: t. 707 (1938b). Holotype: Zoutpansberg Dist.; Chipese, June 1937, Van der Merwe (probably F.Z. van der Merwe) in *National Herbarium, Pretoria, No. 23,301* (= PRE 23005) (PRE!). The type is F.Z. van der Merwe 1377, and not F.Z. van der Merwe s.n. The specimen occupies two sheets, both of which are needed to confirm the identity of this plant. This is a good species.

Leptaloe blyderivierensis Groenew.: in *The Flowering Plants of South Africa* 17: t. 651 (1937). Holotype: Pilgrim's Rest Dist.; on slopes of the Drakensbergen near the Blyde River, about 30 miles north of Pilgrim's Rest, Van der Merwe (probably F.Z. van der Merwe) in *National Herbarium, Pretoria, No. 21361* (PRE!). Reynolds (1950) considered this species to be a synonym of *A. minima* Baker, an opinion with which we agree.

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VERBENACEAE

A NEW SPECIES IN THE GENUS *CLERODENDRUM*

1. *Clerodendrum louwalbertsii* P.P.J. Herman, sp. nov., *C. triphyllum* (Harv.) H. Pearson affinis sed inflorescentia thyrsoida indeterminata, foliis linearibus vel anguste ellipticis differt.

TYPE.—Northern Transvaal, 2428 (Nylstroom): 18 km from Nylstroom on road to Warmbaths near Groot Nylturnoff, (–CD), 1985-11-04, *Germishuizen 3343* (PRE, holo.).

Perennial herb with annual stems arising from woody rootstock, stems unbranched or sparsely branched near base, 200–500(–800) mm tall, angular, glabrous or pilose. *Leaves* ternate, sometimes opposite or in whorls of 4, sessile or subsessile, glabrous or pilose, linear to narrowly elliptic, (20–)25–50(–85) × (2–)3–7(–15) mm, decreasing in size upwards, apex acute, base cuneate, margin entire, semi-succulent, glandular-punctate. *Inflorescence* indeterminate, thyrsoid, bracts similar to leaves but smaller, hypopodium (peduncles) (5–)10–30(–45) mm long, mesopodium 5–16 mm long, epipodium (pedicels) 1.5–4.5 mm long, purplish tinged; prophylls (bracteoles) 2–8(–12) mm long, linear.*

Flowers zygomorphic. *Calyx* tubular, 5-toothed, tube 2.5–3.0 mm long, teeth 1–3 mm long, purplish tinged, persistent. *Corolla* tubular in lower part, with 5 lobes, tube 4–6(–8) mm long, curved; 4 lobes lateral, 5–7 × 3–5 mm, purplish, fifth lobe forming lower lip, 7–10 mm long, darker purple marked with white inverted Y-shaped pattern. *Stamens* 4, purple, long exserted, opposite lower lip and curved downwards, attached ± 1 mm below mouth of corolla tube, bases, where attached to corolla tube, covered with white downwardly directed hairs; filaments 14–21 mm long, anthers 1–2 mm long. *Style* long exserted, purple, 22–27 mm long, curved, stigma of 2 unequal lobes, upper lobe shortest, ± 0.5 mm, lower lobe ± 2 mm long. *Ovary* 4-lobed in upper part, papillose, 2 mm long, imperfectly 4-locular, with a single ovule in each loculus. *Fruit* 1–4 drupes, ripe fruit not seen. Figure 1.

Clerodendrum louwalbertsii has been included under *C. triphyllum* since Pearson's treatment of the genus in *Flora capensis* 5,1 (1912). Some voucher specimens quoted under *C. triphyllum* belong to *C. louwalbertsii*, e.g. *Zeyher 1362* (PRE, TCD) and *Burke 365* (K). The thyrsoid inflorescence and linear leaves clearly distinguish *C. louwalbertsii* from *C. triphyllum* which has axillary cymes in the axils of the lower leaves and leaves which range from oblanceolate to obovate to elliptic (Figure 2).

C. louwalbertsii occurs in Northern Transvaal, the eastern part of the North-West, Gauteng (PWV), Eastern Transvaal and Swaziland, and one specimen was collected at the northern border of Kwa Zulu-Natal (Figure 3). It is found in valleys, kloofs, mountains and hillsides, kop-

pies, grassland and open woodland on sandy, stony or rocky soil, dolomite or granite.

The specific epithet '*louwalbertsii*' was chosen in honour of Dr Louw Alberts, the well-known South African scientist and Christian.

To enable other herbarium workers to distinguish between the two species, the specimens of *Clerodendrum triphyllum* examined are listed below. The distribution of the two species is shown in Figure 3.

2. *Clerodendrum triphyllum* (Harv.) H. Pearson, in *Flora capensis* 5,1: 220, 221 (1901); Thomas: 80 (1936).

Cyclonema triphyllum Harv.: 17, 18, t. 27 (1859).

Icones: Harv.: t. 27 (1859); Phillips: t. 19 (1921).

C. triphyllum occurs in Northern Transvaal, the eastern part of the North-West, Gauteng (PWV), Eastern Transvaal, Orange Free State, Swaziland, Kwa Zulu-Natal, Lesotho and Eastern Cape. It is a typical grassland species.

Specimens examined

Acocks 1918 (2) PRE. *Anderson A41* (2) PRE.

Balkwill & Cadman 3546 (1) J. *Balkwill, Cadman & McCallum 3004* (1) J. *Barnard & Mogg 913* (1) PRE. *Barrett 306* (1) PRE. *Beeton 114* (2) PRE. *Behr 746* (2) PRE. *Bezuidenhout 106* (2) PRE. *Bolus 12236* (1) GRA, PRE. *Botha & Ubbink 1750* (2) PRE. *Botha & Van Wyk 1069* (2) PRE. *Braun 1260* (2) PRE. *Bredenkamp 141* (2) PRE; *236* (2) PRE. *Breyer 17898* (1) PRE. *Brown & Shapiro 209* (2) PRE; *504* (1) PRE. *Buitendag 426* (1) PRE. *Burgoyne 1067* (2) PRE. *Burke 365* (1) K. *Burt Davy 2307, 7098, 7290* (2) PRE.

Clarke 1434 (2) PRE. *Coetzee 227, 343, 533* (2) PRE. *Collins 12188* (2) PRE; *27120* (1) PRE. *Comins 886* (1) PRE. *Compton 27098* (2) PRE; *31232* (1) PRE. *Culverwell 399* (2) PRE; *1423* (1) PRE.

Davidse 5981 (2) PRE. *Davidson 2145* (1) J. *De Souza 638* (2) PRE. *Dieterlen 515* (2) PRE. *Dlamini s.n. PRE31357* (2) PRE. *Dohse 45* (1) NU. *Du Plessis 1012, 1083* (1) PRE. *Du Toit 39, 90* (2) PRE.

Edwards 1089 (2) PRE.

Flanagan 1931 (2) PRE. *Fourie 1/2/30* (2) PRE.

Galpin 509M, 9060 (1) PRE; *12364, 14568* (2) PRE. *Germishuizen 3343* (1) PRE; *3964* (2) PRE. *Germishuizen & Retief 578* (1) PRE. *Gerard & M'Ken 1251* (2) TCD. *Gillfillan 76* (Herb. *Galpin 6166*) (2) PRE. *Glen 1840* (1) J; *2479* (1) J, PRE.

Hanekom 1723 (1) PRE. *Hards 104* (1) PRE. *HBG 26891* (2) PRE; *27051* (2) PRE. *Herman 151, 1357–1370* (1) PRE; *1332, 1375–1388* (2) PRE. *Holden 14156* (2) PRE. *Holt 139* (1) NH, PRE. *Huntley 1124* (2) PRE.

Immelman 83 (1) PRE.

Jacobsen 1863 (2) PRE; *2780* (1) PRE. *Jacobsz 145, 1853, 2002* (2) PRE. *Janse 3166* (1) PRE. *Jenkins 6929, PRE 39926* (1) PRE; *9829* (2) PRE. *Joffe 139* (2) PRE. *Junod 17449* (2) PRE.

Kok 284 (2) PRE. *Kroon 10264* (2) PRE.

Lambinon & Reekmans 82/28 (1) PRE. *Lang, Tvl. Mus. 30314* (2) PRE; *Tvl. Mus. 31067* (1) PRE. *Leendertz 376a* (1) GRA. *Le Roux 14* (2) PRE. *Liebenberg 2507, 8838, 8943a* (1) PRE; *8518* (2) PRE. *L'Ons 60/44* (2) PRE. *Louw 101* (2) PRE. *Lucas 374* (1) J.

Maguire 1264, 1265, 8624 (1) J. *Marloth 3823* (1) PRE; *3855* (2) PRE. *Mauve s.n.* (1) NU. *McCallum 561* (2) PRE. *McMurtry 5235* (1) J. *Medley Wood 3381* (2) NH. *Miller 3878, 8511* (2) PRE. *Mitchley 86* (2) PRE. *Mogg 10127, 14656, 15,336, s.n. PRE 39943* (2) PRE; *31555*

* Terminology of inflorescence according to Weberling (1989).



FIGURE 1.—Holotype of *Clerodendrum louwalbertsii*, Germis-huizen 3343.

(1) J. PRE. Moss 8637, 10826, 16223, 16764, 17820 (1) J. Moss & Oetley s.n. (1) J. Muller 2014 (2) PRE. Murray II (2) PRE. Nation 35 (1) PRE. Nel 290 (1) PRE. Netshungani 665 (2) PRE. Obermeyer 895 (2) PRE. Phillips 18, 3113, 3276 (2) PRE. Pienaar 748 (1) PRE. Pole Evans H13132 (2) PRE. Potgieter 21837 (2) PRE. Prosser P1062 (2) PRE. Pupils of Convent 97 (2) PRE. P. Raal & G. Raal 911 (2) PRE. Rademacher 7306, 7478 (2) PRE. Reid 436 (1) PRE. Repton 160 (1) PRE; 422, 3431 (2) PRE; 754 (1) NH, PRE. Retief 134 (1) PRE. Rogers 2930, 22062 (1) PRE; 12412, 19026, 21580 (2) PRE. Scheepers 694, 1434 (2) PRE. Schijff 471 (2) PRE. Sekhaolelo 156 (1) PRE. Sidey 1944 (2) PRE. Smith 1267, 1278 (1) PRE. Smuts & Gillett 3055, 3326, 4129 (1) PRE. Stirton 5739 (2) PRE. Story 1404 (2) PRE. Sutton 351 (2) PRE. Theron 705, 1405 (1) PRE. Thode A1338, A1631 (2) PRE. Thompson 8011 (2) PRE. Thornicroft 11291 (2) PRE. Tiedt & Young 2159a (1) PRE. Turner 222 (2) PRE. Ubbink & Van Wyk 514 (2) PRE. Van Dam 20755, 27099, 27121 (1) PRE. Van der Merwe s.n. PRE39945 (2) PRE. Van Rooyen 2027 (1) PRE. Van Vuuren 369 (1) PRE. Van Wyk 6875 (2) PRE. Venter 7202 (1) PRE. Verdoorn 141 (1) PRE; 496 (2) PRE. Walker s.n. PRE39923 (2) PRE. Wasserfall & Van Niekerk 41 (1) PRE. Werdermann & Oberdieck 1279 (1) PRE. Young A202 (1) PRE. Zeyher 1362 (1) PRE, TCD; 1363 (2) TCD (type of *Cyclonema triphyllum* Harv.).



FIGURE 2.—Diagram showing the differences in inflorescences of A, *Clerodendrum louwalbertsii* and B, *C. triphyllum*.

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My thanks go to Dr H.F. Glen for the Latin translation; Mrs A. Romanowski for the photograph; Ms G. Condy for the line drawings; to the curators of K and TCD for

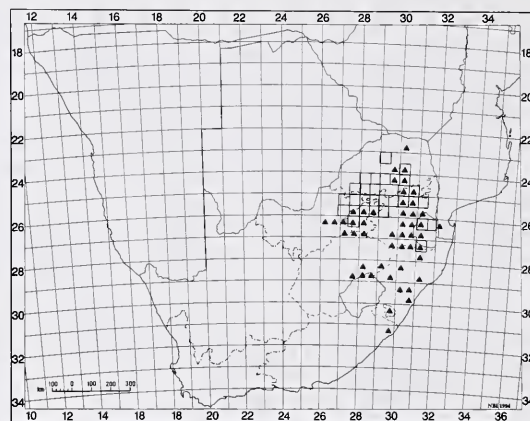


FIGURE 3.—Distribution of *Clerodendrum louwalbertsii*, □; and *C. triphyllum*, ▲.

the loan of material; and to the former Department of Nature Conservation of Bophuthatswana for permission to collect material in the Pilanesberg National Park.

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GERANIACEAE

LECTOTYPIFICATION OF *PELARGONIUM MULTIBRACTEATUM*

In the description of *Pelargonium multibracteatum* in Richard's *Tentamen florae abyssinicae* 1: 119 (1847), two Schimper collections are referred to in the heading of the protologue and a locality for a Schimper collection is given as near Axum in the list of material seen. A further three collections from various localities made by Dillon are cited in the list of material seen. These collections can all be considered to be syntypes.

Up to now no lectotype has been designated for *Pelargonium multibracteatum* in accordance with Art. 9.2 of the ICBN (Greuter *et al.* 1994). In all Kokwaro's papers on the Geraniaceae of northeast Africa (1969, 1971a, 1971b) in which he treated this species, only the syntypes were cited without selecting a lectotype, possibly because

he considered *P. multibracteatum* to be a subspecies of *P. alchemilloides* (L.) L' Hérit. and therefore thought the selection of a lectotype of minor importance. Van der Walt & Vorster (1988: 91) cited all the syntypes seen by them, again declining to select a lectotype. However, for the treatment of *Pelargonium* for the *Flora of Ethiopia* by the senior author, it has become necessary to select a lectotype.

The first question to be addressed is: who is the validating author of the name? Knuth (1912: 433), Dyer (1940: t. 794), and Richard (1847: 119) cited Hochstetter as the author; Engler (1895: 225), Cufodontis (1956: 351), and Kokwaro (1969: 530; 1971a: 666) cited Hochstetter ex A. Richard; Kokwaro (1971b: 21) cited A. Richard; and Van



FIGURE 4.—*Pelargonium multibracteatum*; lectotype sheet (Dillon s.n. in P). Scale bar: A, 100 mm; B, 10 mm.

der Walt & Vorster (1988: 91) cited Hochstetter in A. Richard. According to Friis (1993: 185) practically none of Hochstetter's new names were accompanied by descriptions. The name *Pelargonium multibracteatum* first appeared in print on a herbarium label for *Schimper 51*, distributed by Hochstetter on 26 October 1837; and again on a label for *Schimper 1489*, distributed on 23 November 1842. It also appeared in Hochstetter's (1841) list of *Schimper* collections. None of these publications satisfies the conditions for valid publication (ICBN Art. 32; Greuter *et al.* 1994), and the first description of the species was only published in 1847, by Richard. There is no evidence that Hochstetter contributed towards this description, and therefore Richard is the sole validating author.

The second question is: which specimens did Richard use to compile his description? Following the description, four collections are cited, namely, *Dillon 316* (inter Adoua et Ocbasa), *Dillon 205* (Taccazé), *Dillon s.n.* (Chiré), and *Schimper 1489* (Axoum). However, as authority for the name, Hochstetter's label for *Schimper 51* is also cited. We here accept that Richard did indeed see *Schimper 51*. It is unlikely that he saw a detached label only, and we surmise that he would have been unable to link the name with a species unless he saw an actual specimen.

According to Stafleu & Cowan (1983: 764), the original set of specimens on which Richard's *Tentamen* is based, is lodged in P. They also state that the *Tentamen*

is based on material collected by R. Quartin Dillon and Antoine Petit, but *P. multibracteatum* is clearly also based on *Schimper 51* and *1489*. In P there are indeed specimens of all the collections cited by Richard.

For lectotypification purposes, the three Dillon collections are not particularly suitable, being relatively poor specimens with few duplicates in other herbaria. Of *Schimper 51* there are six sheets in P with numerous duplicates in other herbaria, and of *Schimper 1489* there are two sheets in P with several duplicates in other herbaria. However, the only really good sheets of the Schimper collections bear stamps 'Herb. A. Bunge', 'Herbier E. Drake', and 'Ancien Herbier E. Cosson'. Strictly these are not part of the original material and were probably not seen by Richard, being incorporated into P in 1904 and 1913 (Stafleu & Cowan (1976: 407, 552, 678)). Of the remainder of the sheets in P, the best is *Dillon s.n.* which, although not well annotated, is presumed to be from Chiré. In the absence of contradictory evidence, this sheet is accepted as being one of those studied by Richard, and is here designated as lectotype (Figure 4):

ETHIOPIA.—'in provinciae Chiré', *Dillon s.n.* [P, lecto., here selected; MEL (sub MEL 94226), P, W, isolecto.].

Other original material seen: ETHIOPIA.—'in convalle fluvii Tacczé', *Dillon 205* [P, MEL (sub MEL 94227)]; 'Crescit inter Adoua et Ocbasa', *Dillon 316* (P); 'montis Scholoda', *Schimper 52* [BM (2 sheets), CGE, G, K (2 sheets), L (3 sheets), OXF (2 sheets), P (6 sheets), S (2 sheets), and W (4 sheets)]; 'prope Axoum', *Schimper 1489* [BM, CGE, G (3 sheets), K, L, MO, P (2 sheets), TUB, W].

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ROSACEAE

A NEW SPECIES OF *CLIFFORTIA* FROM THE SWARTBERG

Cliffortia nivenioides Fellingham, sp. nov., *C. aculeatae* Weim. sectionis *Multinerviae* DC. affinis sed foliis brevioribus, lateraliter complanatis, versus sulcatis teretibus, structura interna dissimilibus.

TYPE.—Western Cape, 3322 (Oudtshoorn): Eastern Swartberg, plateau north of Blesberg, 1 900 m, 29 November 1991, *Fellingham & Vlok 1588* (STE, holo.; K, PRE, MO, iso.).

A compact small shrub to 600 mm tall with long emerging procumbent branches spreading over 750 mm, monoecious but apparently of one or the other sex at any given time, female flowers totally hidden in axils of upper leaves. Branches reddish brown, glabrous, older parts with persistent vaginas of fallen leaves with or without internodes in between, axils of some containing either short shoots or long shoots; internodes about 12 mm long. Leaves unifoliate, unifacial, bilaterally flattened, in transverse section elliptic and anatomically centric, closely arranged on the short shoot in a flat slightly elongated

fan; vagina 4–5 mm long, dorsally whitish and with three obscure parallel veins close together, laterally green; stipules, 3–4 mm long, subulate, glabrous, green, proximal edge straight, thick and flat, distal edge curved, membranous and whitish tinged with purple; lamina sessile, glabrous, glaucous green, red-tipped, smooth, drying sulcate, 3.0–33.0 × 1.0–2.0 mm, linear, straight to slightly falcate, base with two colourless cushions at joint to vagina, dorsally with a central nerve the length of leaf and two shorter parallel lateral nerves, ventrally from base upwards channelled for a third to half of its length forming a partial sheath to leaf above, apically tapering to an acute, somewhat dorsiventrally flattened point. *Male flowers*: bracteoles lanceolate-acuminate, 0.5–0.6 mm long, green, glabrous; pedicel and receptacle 1.0 mm long, glabrous; *sepals* 3, 7.0–8.0 × 2.0–2.5 mm, linear-lanceolate, leathery, the young lime green with occasional irregular longitudinal maroon lines, turning pink then maroon and eventually brown; *stamens* (13–)16(–20), *filaments* 6.5 mm long, filiform, maroon, glabrous; *anthers* 1.2 mm long, pink to maroon. *Female flowers*: bracteoles 0.4–0.5

mm long, similar to male bracteoles; pedicel absent or up to 0.4 mm long, thick and fleshy; *sepals* 3, 2.5–3.0 × 1.0–1.2 mm, lanceolate, dorsally concave, persisting in fruit; *ovary* narrowly elliptic in outline, 2.0–2.5 × 0.9–1.0

mm, longitudinally faintly ridged, glabrous; *style* solitary, 0.3–0.5 mm long; *stigma* short, broad, flat, maroon, margins long fimbriate. *Fruit* 4.5–5.5 × 1.9–2.0 mm, ellipsoid, apex truncate, base narrowed, resembling a pedicel, long-



FIGURE 5.—A–H, *Cliffortia niventoides*: A, B, fruit; C, male flower; D, female flower; E, long shoot with short shoots, three lower short shoots showing initial lengthening; F, long shoot with female flowers (above) and developing fruit below; G, male bud; H, male flower in axil of basal leaf of developing long shoot. I–K, *Cliffortia aculeata*: I, J, fruit; K, male bud. a, pedicel; b, bracteole; c, calyx lobe; d, basal part of fruit; e, style. A–H, *Viviers & Vlok 470* (BM, BOL, K, MO, P, PRE, STE); I–K, *Fellingham & Vlok 1590* (K, PRE, STE). Scale bars: 1 mm.

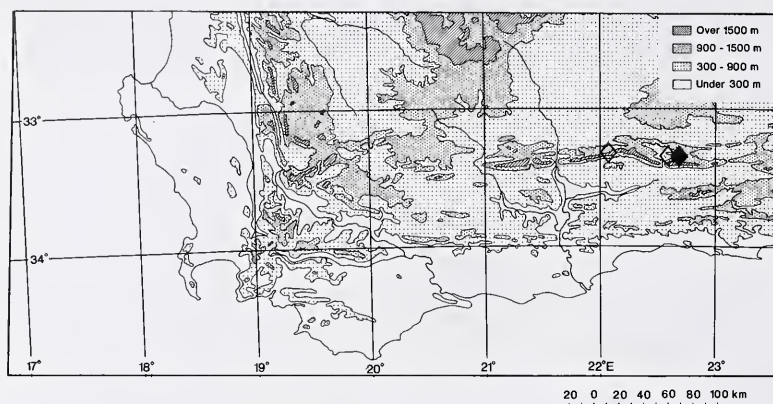


FIGURE 6.—Known distribution of *Cliffortia nivenioides*, ◆, and *C. aculeata*, ◇.

gitudinally faintly ridged, green with a tinge of red (Figure 5A–H).

Diagnostic features

C. nivenioides is similar to *C. aculeata* of the section *Multinerviae* DC., but differs in the more compact, upright growth form (elongated and trailing in *C. aculeata*); the shorter, laterally flattened, wider leaves (terete and somewhat sulcate in *C. aculeata*); the shorter wider calyx lobes; the somewhat different fruit structure; and the different habitat (Figure 5A–H versus 5I–K).

Distribution and habitat

C. nivenioides is known only from a very small area on the plateau north of the Blesberg in the eastern Swartberg, in grassy mountain fynbos on open, sunny, marshy flats. *C. aculeata* occurs nearby, but on a shady vertical cliff face in the spray of a waterfall. It also grows on the Waboomsberg on the eastern side of the Swartberg Pass, again in a shady, moist habitat on a north-facing cliff face (Figure 6).

Discussion

Superficially *C. nivenioides* is very similar to *C. aculeata* in its distribution, growth form, the colouring of stems and leaves, and the arrangement of the leaves in the form of fans. Closer examination, however, reveals significant differences mainly in the leaf anatomy (Figure 7A & B). In *C. nivenioides* the leaf is centric with the palisade continuous except where it is replaced by the dorsal strand of colourless sclerenchymatous tissue supporting the large middle vein with its double phloem elements and phloem cap, but lacking a xylem cap. In *C. aculeata* the leaf is near centric with the diminished adaxial surface in the form of a V-shaped sulcus lined with epidermis lacking stomata and supported by a rectangular strand of tissue comprising large, compactly arranged, thick-walled, colourless cells. At first this colourless strand appeared to be a 'window' but it became clear that it is similar to the abaxial 'vein.' No comparable adaxial structure was found in *C. nivenioides*.

Apart from being shorter and wider, the leaves of *C. nivenioides* are also bilaterally flattened throughout the whole length and channelled, but that, near the base only. The leaves of *C. aculeata*, by contrast, are longer, more

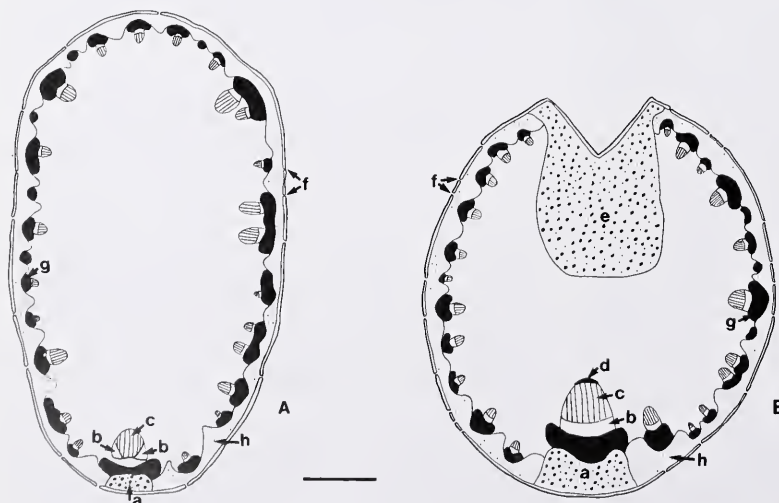


FIGURE 7.—Leaf anatomy. A, *Cliffortia nivenioides*; B, *C. aculeata*. a, colourless sclerenchymatous tissue; b, phloem; c, xylem; d, xylem cap; e, thick-walled colourless cells; f, stomata; g, extraaxillary fibre cap; h, palisade. Scale bar: 10 µm.

slender, subterete, canaliculate throughout their length, and aculeate.

In *C. nivenioides* the calyx lobes in both male and female flowers are shorter and wider (note: the scale bar for Figure 5G is twice the length of that for 5K) and the fruit shorter and more tapered to the ends than in *C. aculeata* (Figure 5B: structure 'd' versus Figure 5I: structure 'd').

The habitat of *C. nivenioides* is sunny, open and flat, whereas that of *C. aculeata* is shady, sheltered and vertical. One collection of *C. aculeata* (Fellingham & Vlok 1593) however, was from a level, sunny and dry site, no more than 4 m away from the vertical stream bank from which a typical specimen (Fellingham & Vlok 1592) was collected. The specimen from the sunny position had shorter leaves which were arranged in more compact fans than those normally found in this species, but rather like the leaves of *C. nivenioides*. It was, in fact, difficult to recognize the plant immediately as *C. aculeata*, and momentary excitement was caused at the thought of this being a possible new find of *C. nivenioides*. On closer examination, however, there was no doubt that it was *C. aculeata*.

C. nivenioides is known from only one very discreet area north of the Blesberg, very close to its related species *C. aculeata*. The latter species was originally discovered on the Swartberg Pass and later on the Waboombesberg. To date no specimens of *C. nivenioides* have been collected from these two localities.

The fan-like arrangement of the leaves in *C. nivenioides* resembles the arrangement characteristic of the genus *Nivenia* Vent. (Iridaceae), prompting the derivation of the specific epithet.

Specimens examined

C. nivenioides sp. nov.

WESTERN CAPE.—3322 (Oudtshoorn): eastern Swartberg, plateau north of Blesberg, next to track; in moist, broad but relatively dry seepage area, 1 880 m, 30-04-1980, (–BC), Bond 1754 (PRE, STE); Swartberg, head of Tierkloof, northwest of Blesberg, marshy flats, 1 900 m, 06-01-1975, (–BC), Thompson 2275 (PRE, STE); Swartberg Mountains, next

to track near Blesberg, in wet humic sandy soil on north-facing slope, 1 900 m, 18-12-1985, (–BC), Vlok 1326 (PRE, STE); eastern Swartberg, plateau north of Blesberg, between E-W running track and the track up Blesberg, open mountain fynbos on peaty soil in marshy area on gentle N slope, 1 900 m, 29-11-1991, (–BC), Fellingham & Vlok 1588 (K, MO, PRE, STE); Swartberg Mountains, on plateau just north of Blesberg, next to forestry track, in deep peaty sandy soil in seepage on gentle north-facing slope in grassy mountain fynbos, 1 900 m, 30-01-1990, (–BC), Viviers & Vlok 470 (BM, BOL, K, MO, P, PRE, S, STE).

C. aculeata Weim. in Botaniska Notiser 4: 410 (1946). Type: Swartberg Pass growing in wet places near stream, 00-12-1945, Stokoe 9250 (LD, holo.; NBG, iso. !).

WESTERN CAPE.—3322 (Oudtshoorn): upper northern slopes of Waboombesberg, next to perennial stream in deep moist sand, 1 600 m, 26-12-1984, (–AC), Vlok 879 (PRE, STE); Swartberg, Waboombesberg, about 15 km along road to Die Hel at foot of mountain, mountain fynbos on edge of stream, in shade, few plants hanging down from vertical streambank, 1 860 m, 30-11-1991, (–AC), Fellingham and Vlok 1592 (PRE, STE); Swartberg, Waboombesberg, about 15 km along road to Die Hel, at foot of mountain, in mountain fynbos in dry streambed in full sun, 1 860 m, 30-11-1991, (–AC), Fellingham & Vlok 1593 (PRE, STE); Swartberg Pass, damp places, 00-12-1942, (–AC), Stokoe SAM 58304 (SAM); Swartberg Pass, 1 600 m, 00-01-1944, (–AC), Stokoe SAM 58303 (PRE, SAM); 8 miles west of top of Swartberg Pass, 1 600 m, 00-10-1951, (–AC) Stokoe SAM 67049 (PRE, SAM); Swartberg Pass, 12-12-1942, (–AC), Stokoe 8606 (PRE); Swartberg Mountains, mid northern slopes of Blesberg, near forestry track, in deep moist loamy soil next to perennial stream on north-facing slopes in grassy disturbed mountain fynbos, 1 400 m, 15-12-1986, (–BC), Vlok 1777 (STE); eastern Swartberg, Blesberg area, top of Tierkloof, vertical north-facing seep, 29-11-1991, (–BC), Fellingham & Vlok 1590 (K, PRE, STE).

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ASTERACEAE

A NEW SPECIES OF *TRICHOGYNE* FROM NAMAQUALAND

Trichogyne lerouxiae Beyers, sp. nov. *T. verticillatae* (L. f.) Less. in facie maxime similis sed floribus tribus femineis in quoque capitulo, bracteis circum floribus hermaphroditis rotundatis ad obtusis, pappo paucis vel nullo differt; et *T. polycnemoidi* (Fenzl) Anderb. affinis sed bracteis involucribus dissimiliter coloratis et numero florum femineorum in quoque capitulo facile distinguenda.

TYPE.—Northern Cape, 3017 (Hondeklip Bay): Namaqualand, 15 km west of Soebatsfontein on road to Riethuis, (–AB), 14-08-1982, Le Roux 2918 (STE, holo.; PRE, iso.). Figure 8.

Annual viscid erect herb, 40–150 mm tall. *Stems* few to several from the crown, simple or branching near base,

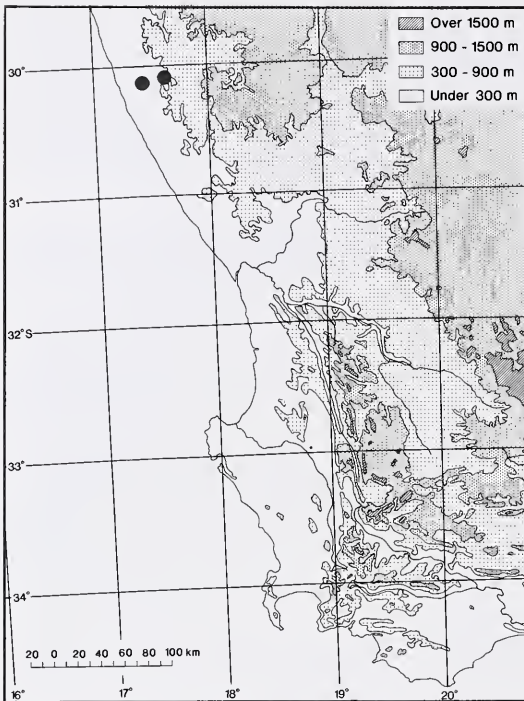


FIGURE 8.—The known distribution of *Trichogyne lerouxiae*.

leafy, with thin cobweb-like indumentum, becoming glabrous. *Leaves*: primary leaves $6.5\text{--}10 \times 0.5\text{--}1$ mm, linear-filiform, usually twisted, apex mucronulate, margins involute, abaxial surface with thin cobweb-like indumentum sometimes glabrescent towards apex, adaxial surface white tomentose; secondary leaves similar but much shorter. *Heads* campanulate, $2.2\text{--}2.7 \times 0.9\text{--}1.5$ mm, 3 to few in small leafy clusters in axils of primary leaves, which much exceed them. *Involucral bracts* 10–11, the outer 2–3 sterile, elliptic to obovate, apex acute or rounded; following 3 subtending female flowers, readily deciduous, elliptic, obovate or trullate, adaxially concave, abaxially keeled, apex acute or rounded; inner 5 surrounding hermaphrodite flowers, persistent, of which outer 2 trullate, adaxially concave, abaxially convex, apex rounded and innermost 3 elliptic, ovate or obovate, flat-ish, apex rounded or obtuse; all bracts translucent pale golden brown, abaxial surface pilose but 3 innermost bracts surrounding hermaphrodite flowers glabrescent. *Flowers* 4–6; 3 female, corolla filiform, style divided, 2–(3) hermaphrodite, corolla cylindric below, campanulate above, style undivided. *Achenes* 0.8–1.0 mm long, obovoid with minute clavate hairs, ovaries of hermaphrodite flowers aborted. *Pappus* absent in female flowers, scanty or absent in hermaphrodite flowers, slender setaceous with shaft naked below, shortly plumose towards tip. Figures 9 & 10.

Anderberg (1991) has reinstated the genus *Trichogyne* Less. which Hilliard (1981) had regarded as a subgenus of *Ifloga* Cass. This new species has been placed in the genus *Trichogyne* as its outer female florets are subtended by bracts, its functionally male disc florets have undivided styles, and its pappus bristles are apically plumose and

basally without patent cilia, thus corresponding to the characters defined by Anderberg (1991). *T. lerouxiae* resembles *T. verticillata* in general facies, but differs in having 3 [not (0)–1–2] female flowers in a head, the rounded to obtuse (not acuminate) bracts which surround the hermaphrodite flowers and the scanty or absent (not present) pappus. Its affinities also lie with *T. polycnemoides* but it can be readily distinguished by the differently coloured involucral bracts (translucent straw-coloured versus reddish central patch with whitish tip) and the number of female flowers (3 versus 5–10) in a head.

T. lerouxiae is only known from two localities in the sandveld of Namaqualand growing in sandy clay soil at altitudes ranging from 150–250 m. According to Hilliard (1981), *T. verticillata* is confined to the southwestern Cape, with its western distribution as far north as Lambert's Bay occurring on coastal dunes and low-lying sandy flats at altitudes not above 250 m. *T. polycnemoides* on the other hand occurs in Namaqualand, and is confined to altitudes between 600 and 900 m.

Specimens examined

NORTHERN CAPE.—3017 (Hondeklip Bay): Namaqualand, 15 km W of Soebatsfontein on road to Riethuis, 150 m, (–AB), 14-08-1982, *Le Roux* 2918 (PRE, STE); Namaqualand, Kookfontein 466, 250 m, (–BA), 03-09-1986, *Le Roux & Lloyd* 458 (STE).



FIGURE 9.—*Trichogyne lerouxiae*: holotype, illustrating habit, *Le Roux* 2918 (STE).

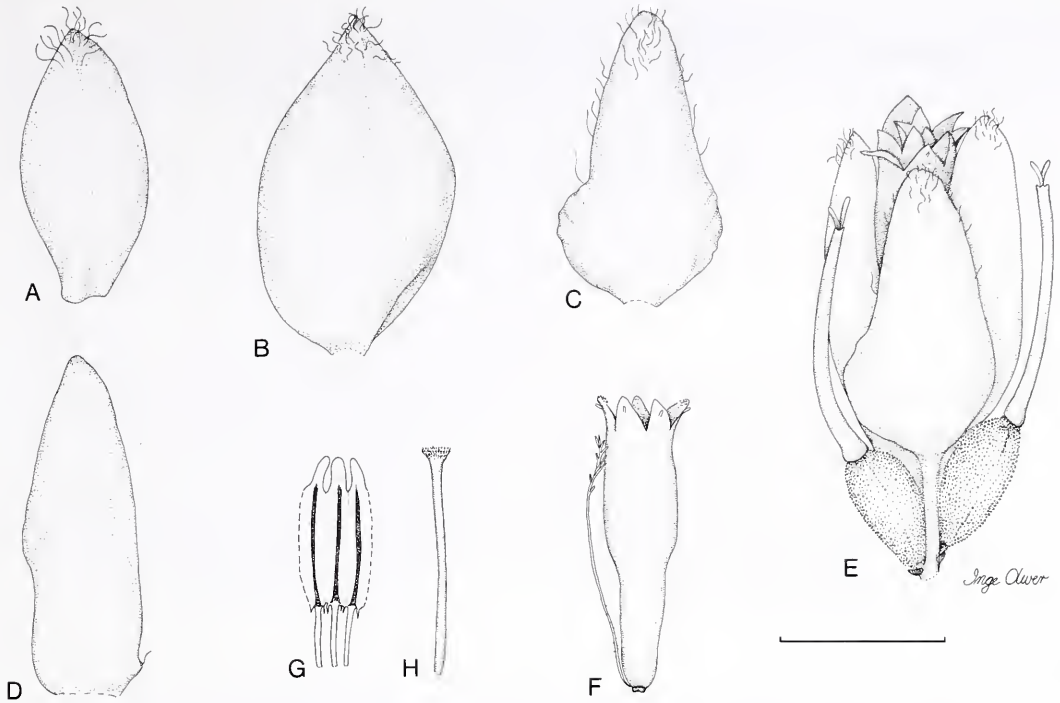


FIGURE 10.—*Trichogyne lerouxiae*. A–D, involucral bracts, abaxial view: A, sterile bract; B, bract subtending female flower; C & D, persistent bracts surrounding hermaphrodite flowers. E, head with deciduous bracts removed to reveal two female flowers. F–H, hermaphrodite flower: F, with pappus; G, stamens; H, style. All drawn from the type, *Le Roux 2918* (STE). Scale bar: 1 mm.

It gives me great pleasure to name this new species after Ms Annelise le Roux who has for many years been involved with the study and conservation of the flora of Namaqualand and is the co-editor of the forthcoming *Flora of Namaqualand* for which this new species is required.

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Preliminary ethnobotanical studies of the Rwenzori Mountain forest area in Bundibugyo District, Uganda

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ABSTRACT

Ethnobotanical studies of the Rwenzori Mountain forest area in Bundibugyo District in Uganda were carried out between May and December 1991, and covered the northern part of the Rwenzori Mountain slopes occupied by the Bakonjo people.

The presence of a major footpath through the forest with numerous utility trails radiating from it showed that some forest resources are being sought by the local population. Plant biodiversity is high, as is indicated by the fact that in a study plot of only 4 250 m², a total of 115 plant species, 101 genera and 57 families were identified from a collection of 300 plant specimens.

Seventy-seven plant species were found to be of some importance to the local communities. Out of the 77 useful plant species recorded: 22 species were used for medicinal purposes; 16 for firewood; 13 for construction, joinery and furniture; 12 for craftwork; 10 provided edible fruits and vegetables; and 27 were used for a variety of other purposes. These other purposes include construction of shrines, covering of granary floors, use as toilet paper, carrying luggage, and fodder for goats, sheep and cattle. *Arundinaria alpina* K. Schum. (bamboo) is the species that is most extensively harvested from the forest.

UITTREKSEL

Etnobotaniese studies van die woudgebied van die Rwenzoriberg in die Bundibugyo-distrik in Uganda is tussen Mei en Desember 1991 onderneem. Die noordelike deel van die hange van die Rwenzoriberg waar die Bakonjo-volk woon, is gedek.

'n Breë voetpad deur die woud met talle dienspaadjies wat daaruit lei, was 'n aanduiding dat bronne in die woud deur die plaaslike bevolking benut word. Plantbiodiversiteit is hoog, soos blyk daaruit dat in 'n studieperseel van slegs 4 250 m², 'n totaal van 115 plantspesies, 101 genusse en 57 families in 'n versameling van 300 planteksemplare geïdentifiseer is.

Sewe-en-sewentig spesies is deur die plaaslike gemeenskappe benut. Van die 77 nuttige plantspesies aangeteken, is 22 vir geneeskundige doeleindes gebruik, 16 vir vuurmaakhout, 13 vir konstruksie, skrynwerk en meubels, 12 vir handwerk; 10 het eetbare vrugte en groente opgelewer, en 27 is vir 'n verskeidenheid ander doeleindes gebruik. Voorbeelde hiervan is die konstruksie van altare, bedekking van graanskuurvloere, benutting as toiletpapier, die dra van bagasie, en voer vir bokke, skape en beeste. *Arundinaria alpina* K. Schum. (bamboes) is die spesie wat die meeste uit die woud verwyder word.

INTRODUCTION

In the conservation of forests our governments quite often have taken no account of the non-timber products important in national economies. This attitude has also been observed in Latin America's humid tropical forests (Pinedo-Vasquez *et al.* 1990). Prance *et al.* (1987) classified these non-timber products into craft materials, medicinals, seeds and fruits and other edibles, as well as sources of latex, construction fibres and poles and many other goods that cannot easily be categorized.

Studies of the vegetation of Uganda are available (Snowden 1953; Langdale-Brown 1960; Lind & Tallantire 1975; Hamilton 1984; Howard 1991), but few ethnobotanical studies have been carried out. There is also a general lack of public awareness in Uganda of the values of wild plants and the need to use them sustainably. This has led to careless and wanton destruction of many valuable plant species with unacceptable consequences (Karani 1982; Hamilton 1984).

Sociobotanical studies in Uganda have mainly addressed the relationship between humans and plants as defined in terms of cultural use. The main aim has been to explore human use of certain plants and how such plants are identified with particular social situations. It is in this identification that the social or cultural value of a plant is seen to be institutionalized in people's culture. For instance, some scholars have focused on the importance of the banana plant to the Baganda culture, millet to some aspects of culture of the Iteso and the story of the barkcloth in Buganda (Musoke 1975; Nyanzi-Makumbi 1976; L'Obwolo 1980).

With regard to traditional medicines, there are two distinct groups of people who deal with illnesses. These are the 'medicine man' or the 'diviner' who not only issues medicines but is also socially sanctioned to explain the cause(s) of illnesses. The other group is made up of herbalists who literally deal exclusively with herbs and herbal medicines for specific illnesses but not with their supposed underlying supernatural causes. Ogwal & Kakudidi (1989 unpublished) have made some preliminary collections of medicinal plants which have been deposited in the Herbarium of the Department of Botany, Makerere University.

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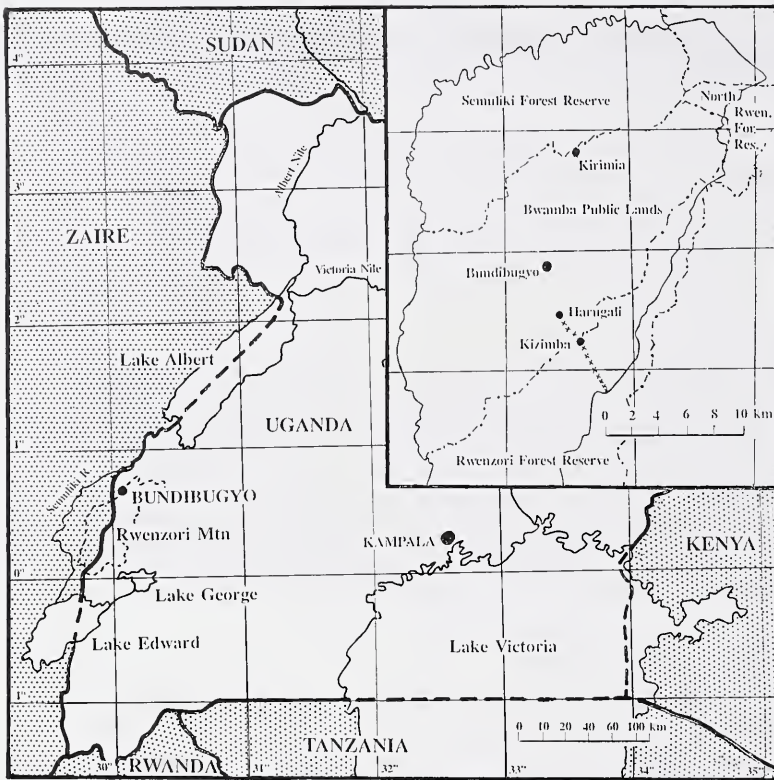


FIGURE 1.—Map of Uganda with study site of the Rwenzori Mountain forest area in Bundibugyo District, —, forest reserve boundary; xxx, Bupumpoli Ridge (25°9-91).

In Uganda, Anokbongo (1972) undertook a general pharmacological experimental study of nine local medicinal plants with a view to confirming or disproving their pharmacological and medicinal potency. Kokwaro (1976) in his book entitled *Medicinal plants of East Africa* briefly discussed a number of medicinal plants used in Kenya and Tanzania. Cunningham (1990) reported a massive trade in herbal medicines among the Zulu people of South Africa. Other publications on medicinal plants of Africa include those of Watt & Breyer-Brandwijk (1962) on *Medicinal and poisonous plants of southern and eastern Africa* and Verdcourt & Trump (1969) on *Common poisonous plants of East Africa*.

Our project was intended to cover some ethnobotanical aspects of the Bakonjo and Baamba who live in Bundibugyo District on the northern slopes of the Rwenzori Mountains. The Rwenzori Forest Reserve Area was gazetted as a National Park in 1991 by the Uganda Government.

Objectives of the project included making an inventory of the plants in the Rwenzori Forest Reserve Area, undertaking ethnobotanical studies of the forested area and its environs, stimulating public awareness of the importance of sustainable utilization of wild plants, identification of conservation problems and enhancing local participation in finding solutions for such problems.

Apart from timber-producing trees, scientific information on other plants in the mountain region has not been documented. It is speculated that nine species of higher plants are endemic to the Rwenzori Mountain region

(Howard 1988). Such rare plant species need to be properly documented and conservation measures adopted to protect them from becoming extinct.

STUDY SITES AND METHODS

The study locale is on Bupumpoli Ridge, on the northern part of the Rwenzori Mountain in Bundibugyo District, Uganda: lat. 0°43'N to 0°45'N; long. 30°03'E to 30°07'E (Ref.: Fort Portal Map 1: 250,000). Figure 1.

The flats on the northern foot of the mountains lie within the East African Rift Valley System and are at an altitude of about 600 m. The land rises to about 3 650 m at Karangora, the highest point in Bundibugyo.

Field work was carried out between May and December 1991. This involved camping at two sites. The first camping site was at Bupumpoli Primary School, two and a half hours walk up to the forest edge of the Bupumpoli Ridge. The second camping site was located in Kizimba Village close to the forest. The study utilized a major human footpath passing over Bupumpoli Ridge (Figure 1). Secondary trails radiating from the main footpath were treated as transects. In all, six transects of different lengths were used.

A number of sample plots were studied in each transect, depending on the length of each trail. Transect I consisted of four sample plots, transect II of three, transect III of two, transect IV of three, transect V of four sample plots and transect VI of one sample plot. Each sample



FIGURE 2.—A group of Bakonjo transporting bamboo, *Arundinaria alpina*, from the forest (25-9-91).

plot had the dimensions of 50×5 m, making a total sample area of 4 250 m².

Specimens of every plant species found in each of the sample plots were collected, whereas only the presence was recorded if already collected. Specimens of very tall trees were not in many cases collected because of inaccessibility of the branches. The names of such tall trees, where known, were written down. As the plants were being collected, the Field Assistants (local to the area) were asked to give vernacular names whenever possible.

The local use(s) of the plants collected were recorded. Plant specimens collected were brought to the camping sites where people were asked to give vernacular names and uses. The specimens were then prepared for pressing and later identified by reference to material in the herbarium of the Department of Botany, Makerere University. Our vouchers were deposited in the same herbarium.

Interviews were also conducted among the people in Kizimba Village about their attitudes towards the forest reserve bordering their village. They were asked about the values of the land use practices and associated problems. Finally, the villagers were also asked about their history of settlement in this area close to the forest reserve.

RESULTS

Local communities

There are two major indigenous ethnic groups inhabiting Bundibugyo District. These are the Baamba and the Bakonjo. The Baamba inhabit the flat areas between the mountains while the Bakonjo occupy the higher slopes. The Baamba have a medium population density of about 50/km² except in areas of forest reserves where they are

not allowed to settle, while the Bakonjo have a higher population density except in the gullies which are uninhabited. The Baamba extensively grow wheat, potatoes, cabbages and coffee whereas the Bakonjo grow coffee and cocoa.

Harvesting of forest plants

The existence of a major footpath passing through the forest reserve (now a National Park) from Bundibugyo District to Kabarole District shows that some business is being conducted between the two districts. Secondly, the presence of numerous secondary trails radiating from the major footpath into the forest shows that there are certain things the people are collecting in the forest. This study revealed that 77 plant species collected from the forest had some use locally. The most notable forest plant harvested by the Bakonjo was *Arundinaria alpina* (Figure 2). Tables 1–6 & 8 show different ways in which the Bakonjo and Baamba use wild plants from the forest or their surroundings.

Medicinal plants

From our interviews in the local communities we found that 22 plant species were used for treating a variety of diseases or medical conditions (Table 1). These include grey speck in the eye, diarrhoea, boils, skin rashes, hypertension, stomach ache, tapeworm, fever and other bodily pains. Some species were also purportedly used for increasing sexual potency in men and others were used for driving out evil spirits from people. Herbs constituted 59.1% (13/22) of the medicinal plants, 13.6% (3/22) were shrubs, 18.2% (4/22) were climbers and 9.1% (2/22) were trees. Most of the medicinal plants were prepared by crushing the plant materials and using water to extract the active ingredients. The water extracts were mainly administered orally or applied directly to the affected part of the body. The medicinal plants made up 28.6% (22/77)

TABLE 1.—Species used by the Bakonjo and Baamba as medicinals

Family	Taxon	Voucher no.	Habit	Part used	Preparation	Medical treatment
Asclepiadaceae	<i>Mondia whitei</i> (Hook f.) Skeels	87	climber	stems and roots	Chewed	Stimulating sexual potency in man
Asteraceae	<i>Crassocephalum</i> sp. 1	8	herb	leaves	Pounded and extracted with water	Diarrhoea
	<i>Crassocephalum</i> sp. 2	34	herb	leaves	Pounded and extracted with water	Diarrhoea
	<i>Dichrocephala integrifolia</i> Katz	54	herb	stems	Cut and tied round head	Driving out evil spirits from patients
Chenopodiaceae	<i>Chenopodium ambrosioides</i> L.	129	herb	roots	Pounded and extracted with water	Stomachache and worms
	<i>C. procerum</i> (Hochst.) Mez	130	herb	roots	Pounded and extracted with water	Stomachache
Cucurbitaceae	<i>Coccinia mildbraedii</i> Harms	114	herb	stems and roots	Pounded and rubbed on body	Easing muscular pain
	<i>Lagenaria sphaerica</i> (Sond.) Naudin	108	climber	roots	Chewed	Stomachache
	<i>Monordica foetida</i> Schumach.	61	climber	stems	Pounded and extracted with water	Fever and stomachache
	<i>M. pterocarpa</i> A. Rich.	104	climber	stems	Pounded and extracted with water	Stomachache
	<i>Peponium vogelii</i> (Hook. f.) Engl.	98	herb	roots	Pounded and extracted with water	Stomachache
Euphorbiaceae	<i>Acalypha psilostachya</i> Hochst.	59	shrub	leaves	Pounded and extracted with water	Stomachache and broken bones
Fabaceae	<i>Desmodium repandum</i> Vahl	7	herb	leaves	Pounded and extracted with water	Diarrhoea
Lamiaceae (= Labiatae)	<i>Plectranthus laxiflorus</i> Benth.	10	herb	roots	Pounded and juice squeezed out	Boils
Liliaceae s.l.	<i>Dracaena afromontana</i> Mildbr.	11	tree	leaves	Pounded and extracted with water	Hypertension
Musaceae	<i>Ensete edule</i> J.F. Gmel.	113	herb	leaf bases	Cut fleshy leaf bases	Lameness in children
Myrtaceae	<i>Enbelia schimperi</i> Vatke	46	shrub	fruits and leaves	Eaten and chewed respectively	Tapeworm and stomach-ache
	<i>Maesa lanceolata</i> Forssk.	44	tree	bark	Pounded and extracted with water	Stomachache and bodily pains
Piperaceae	<i>Piper capense</i> L. f.	30	shrub	leaves	Pounded and extracted with water	Boils
Plantaginaceae	<i>Plantago palmata</i> Hook. f.	103	herb	leaves	Tied round wrists	Protection against dangers
Polygonaceae	<i>Polygonum setosulum</i> A. Rich.	57	herb	leaves	Boiled in water	Whooping cough
Rosaceae	<i>Alchemilla kiuwnensis</i> Engl.	2	herb	leaves	Pounded and juice squeezed out	Grey speck in eye

of the useful plant species and 19.1% (22/115) of all plant species documented.

Among the plant species identified as medicinals, species of the family Cucurbitaceae made up 22.7% (5/22) of the 14 families. Members of the family Asteraceae accounted for 13.6% (3/22), species of Chenopodiaceae and Myrtaceae each 9.1% (2/22). The remaining families had only one species each of medicinal value.

Firewood

Sixteen plant species were identified as being used as firewood (Table 2). This is quite a large number of plant species sought for by villagers close to the forest. Trees constituted 62.5% (10/16) of the plant species used as firewood, 25% (4/16) were shrubs and 12.5% (2/16) were herbs. The herbs and shrubs were mainly fetched from the vicinity of homes where most trees had been cut down

to make room for agriculture. The herbs and shrubs were gathered for fast cooking or when it was too late for travelling long distances for more substantial fuel. Twenty five per cent (4/16) of the plant species used as firewood by the Bakonjo and Baamba belonged to the genus *Vernonia* of the family Asteraceae. Families Acanthaceae and Myrsinaceae had two species each, and Rubiaceae had three species used as firewood.

Construction

A fairly large number of plant species from the forest were also used for construction, mainly as poles, rafters or fibres (Table 3). Timber production was not carried out to any significant degree because the terrain made motorized transportation very difficult. Trees made up 76.9% (10/13) of the plant species used for construction joinery and furniture. One (1/13) was a climber and one

TABLE 2.—Forest species used by the Bakonjo and Baamba as firewood

Family	Taxon	Voucher no.	Habit
Acanthaceae	<i>Brachystephanus coeruleus</i> S. Moore	4	hcrb
	<i>Mimulopsis runssorica</i> Lindau	15	shrub
	<i>Ilex mitis</i> Radlk.	49	tree
Aquifoliaceae	<i>Vernonia adolphi-fridericii</i> Muschl.	12	shrub
Asteraceae	<i>V. auriculifera</i> Hiern	64	tree
	<i>V. cinerea</i> (L.) Less.	75	herb
	<i>V. syringifolia</i> O. Hoffm.	76	shrub
	<i>Macaranga kilimandscharica</i> Pax	41	tree
Euphorbiaceae	<i>Xymalos monospora</i> (Harv.) Warb.	38	tree
Monimiaceae	<i>Maesa lanceolata</i> Forssk.	44	tree
Myrsinaceae	<i>Rapanea melanophloeos</i> (L.) Mez	42	tree
Poaceae	<i>Arundinaria alpina</i> K. Schum.	80	tree
Rubiaceae	<i>Galiniera saxifraga</i> (Hochst.) Bridson	29	shrub
	<i>Psychotria mahonii</i> C.H. Wright var. <i>puberula</i> (Petit) Verdc.	23	tree
	<i>Ryigiynia rwenzoriensis</i> (De Wild.) Robyns	47	tree
	<i>Dombeya elliotii</i> K. Schum.	58	tree

a tree fern. *Arundinaria alpina* was the most extensively used material.

Plant species used for construction, joinery and furniture made up 16.9% (13/77) of useful plant species and 11.3% (13/115) of all plant species recorded. Angiosperms constituted 93% (107/115) of the plant species documented and only 7.8% (9/115) were ferns. Some other trees such as *Macaranga kilimandscharica*, *Canthium oligocarpum*, *Dombeya elliotii* and *Xymalos monospora* were used as central and wall-supporting poles in buildings.

Craftwork

In the making of craftwork, a total of 12 plant species were documented as being valuable to the Bakonjo and Baamba (Table 4). Trees made up 58.3% (7/12) of the plant species used for craftwork, 16.7% (2/12) were

TABLE 4.—Species used for craftwork by the Bakonjo and Baamba

Family	Taxon	Voucher no.	Habit
Boraginaceae	<i>Cordia mellenii</i> Baker	118	tree
Connaraceae	<i>Connarus longistipitatus</i> Gilg	17	shrub
Cyperaceae	<i>Cyperus dereilema</i> Steud.	67	grass
Malvaceae	<i>Sida veronicifolia</i> Lam.	119	shrub
Monimiaceae	<i>Xymalos monospora</i> (Harv.) Warb.	38	tree
Moraceae	<i>Ficus natalensis</i> Hochst.	93	tree
Musaceae	<i>Ensete edule</i> J.F. Gmel.	113	tree
Myrsinaceae	<i>Rapanea melanophloeos</i> (L.) Mez	42	tree
Rubiaceae	<i>Canthium oligocarpum</i> Hiern	22	tree
Smilacaceae	<i>Smilax anceps</i> Willd.	90	climber
Theaceae	<i>Melchiora schliebenii</i> (Melch.) Kobuski	35	tree
Urticaceae	<i>Urera hypselodendron</i> Hochst.	106	climber

shrubs, and 16.7% (2/12) were climbers. One species was a grass.

Other craftwork include baskets made from *Sida* cf. *humilis* and *Smilax anceps*, as well as combs, axe handles, mortars and pestles made from *Connarus longistipitatus*, *Canthium rwenzoriense*, *Melchiora schliebenii* and *Rapanea rhododendroides*. Plant species used for craftwork made up 15.6% (12/77) of useful plants and 10.4% (12/115) of all plants recorded.

Food

Ten plant species were said to be used as food (Table 5). These consisted mainly of edible fruits and vegetables. They were not harvested in large quantities according to information obtained from the Field Assistants. The number of plant species used by the Bakonjo and Baamba as food was rather small. They made up only 13% (10/77) of useful plant species and 8.7% (10/115) of all plant species recorded. The number of wild species collected for food was small, probably because both the Bakonjo and Baamba are able to grow most of the food crops they need.

TABLE 3.—Species used by the Bakonjo and Baamba for construction and timber sales

Family	Taxon	Voucher no.	Habit	Specific use(s)
Boraginaceae	<i>Cordia millenii</i> Baker	118	tree	Timber production
Convolvulaceae	<i>Ipomoea</i> sp.	123	climber	Rope for tying bamboos
Cyatheaceae	<i>Cyathea manniana</i> Hook.	97	tree fern	Construction poles
Euphorbiaceae	<i>Macaranga kilimandscharica</i> Pax	41	tree	Construction poles
Monimiaceae	<i>Xymalos monospora</i> (Harv.) Warb.	38	tree	Construction poles
Oleaceae	<i>Strombosia scheffleri</i> Engl.	50	tree	Timber production and construction poles
Passifloraceae	<i>Adenia</i> sp.	94	climber	Construction fibres
Poaceae	<i>Arundinaria alpina</i> K. Schum.	80	tree	Construction poles and thatching
Rosaceae	<i>Prunus africana</i> (Hook. f.) Kalkm.	20	tree	Construction poles
Rubiaceae	<i>Canthium oligocarpum</i> Hiern	22	tree	Construction poles
Sapotaceae	<i>Aningeria adolphi-fridericii</i> (Engl.) Robyns & Gilbert	19	tree	Timber production and construction poles
Sterculiaceae	<i>Dombeya elliotii</i> K. Schum. & Engl.	58	tree	Construction poles
Theaceae	<i>Melchiora schliebenii</i> (Melch.) Kobuski	35	tree	Construction poles

TABLE 5.—Species used for food by the Bakonjo and Baamba communities

Family	Taxon	Voucher no.	Habit	Part eaten
Balsaminaceae	<i>Impatiens congolana</i> Schtschenk.	72	herb	fruits
	<i>I. rumssorensis</i> Warb.	100	herb	fruits
Myrtaceae	<i>Embelia schimperi</i> Vatke	46	herb	leaves
	<i>Maesa lanceolata</i> Forssk.	44	tree	leaves
Passifloraceae	<i>Passiflora edulis</i> Sims	31	herb	fruits
Polygonaceae	<i>Polygonum setosulum</i> A. Rich.	57	herb	stems
Solanaceae	<i>Capsicum annum</i> L.	81	shrub	fruits
	<i>Solanum nigrum</i> L.	105	herb	leaves
Urticaceae	<i>Droguetia iners</i> (Forssk.) Schweinf.	117	shrub	leaves
	<i>Urera hypselodendron</i> Hochst.	106	climber	leaves

Minor uses

Another group of plant species was said to be used for miscellaneous purposes (Table 6). This category of plants made up 35.1% (27/77) of useful plant species and 23.5% (27/115) of all plants listed. Such purposes included construction of shrines, protection of crop fields against other people's evil motives, making of flutes and charms, covering granary floors, use as toilet paper, trapping birds, car-

rying luggage and fodder for livestock. Herbs constituted 59.3% (16/27) of this miscellaneous group of species, 25.9% (7/27) were shrubs, 11.1% (3/27) were trees and only one species was a grass. The families Aspleniaceae and Asteraceae were the most important in this category of uses, collectively making up 40.7% (11/27) of the species. Twelve other families constituted 44.4% of the species listed.

No special value

A relatively large number of plant species identified, 33% (38/115), had no economic value to the Bakonjo and Baamba communities. These fell into 26 families, 37 genera and 38 species (Table 7).

The floristic composition of this category of plants was 10.8% (4/37) grasses, 54.1% (20/37) herbs, 13.5% (5/37) shrubs, 5.4% (2/37) climbers and 18.9% (7/37) trees.

DISCUSSION

Of the plant species documented, 67% (77/115), were found to be useful in one way or the other by the Bakonjo and Baamba communities interviewed. This level of utilization falls within the range of 48.6% to 78.7% recorded for the Amazonian Parc, Tembe, Kaapo and Chacobo communities by Prance *et al.* (1987). Pinedo-

TABLE 6.—Miscellaneous uses of plant species by the Bakonjo and Baamba

Family	Taxon	Voucher no.	Habit	Uses of plants
Acanthaceae	<i>Mimulopsis rumssorica</i> Lindau	15	shrub	fodder
	<i>Thumbergia mildbraediana</i> Lebrun & Touss.	27	herb	fodder
Amaranthaceae	<i>Cyathula cylindrica</i> Mez	25	herb	fodder
Aspleniaceae	<i>Asplenium abyssinicum</i> Fée	16	herb	making shrines
	<i>A. aethiopicum</i> (Burm. f.) Bech.	37	herb	making shrines
	<i>A. elliptii</i> C.H. Wright	52	herb	making shrines
	<i>A. erectum</i> var. <i>usanbarensis</i> Willd.	68	herb	making shrines
	<i>A. inaequilaterale</i> Willd.	69	herb	making shrines
	<i>A. linckii</i> Kuhn	70	herb	making shrines
	<i>Helichrysum</i> sp.	78	herb	carrying luggage
Asteraceae	<i>Vernonia adolfi-fridericii</i> Muschl.	12	shrub	toilet paper
	<i>V. anriculifera</i> Hiern	64	tree	toilet paper
	<i>V. cinerea</i> (L.) Less.	75	herb	toilet paper
	<i>V. syringifolia</i> O. Hoffm.	76	shrub	toilet paper
	<i>Basella alba</i> L.	82	herb	fodder
Dennstaedtiaceae	<i>Pteridium aquilinum</i> (L.) Kuhn	84	herb	granary cover and covering food while cooking
Euphorbiaceae	<i>Acalypha psilotachya</i> Hochst.	59	shrub	fodder
	<i>Phyllanthus amarus</i> Schumacher & Thonn.	43	herb	fodder
Fabaceae	<i>Eriosema</i> sp.	21	shrub	trapping birds
Liliaceae s.l.	<i>Anthericum</i> sp.	33	herb	making charms
	<i>Dracaena afromontana</i> Mildbr.	11	tree	making shrines
Poaceae	<i>Panicum trichocladium</i> K. Schum.	62	grass	fodder
Polypodiaceae	<i>Athyrium scandiacum</i> (Willd.) C. Presl	26	herb	granary cover
Solanaceae	<i>Discopodium penninervium</i> Hochst.	48	tree	trapping birds
	<i>Solanum aculeatissimum</i> Jacq.	81	shrub	making charms
Thelypteridaceae	<i>Thelypteris dentatus</i> Forssk.	63	herb	making shrines
Verbenaceae	<i>Clerodendrum</i> cf. <i>johustonii</i> Oliv.	109	shrub	drinking straws/smoking pipes

TABLE 7.—Species with no reported economic value to the Bakonjo and Baamba

Family	Taxon	Voucher no.	Habit
Acanthaceae	<i>Acanthus eminens</i> C.B. Cl.	5	shrub
	<i>Asystasia gangetica</i> (L.) T. Anderson	91	herb
Amaranthaceae	<i>Achyranthes aspera</i> L.	14	herb
	<i>Amaranthus lividus</i> L.	115	herb
Amaryllidaceae	<i>Scadoxys cyrtanthiflorus</i> (C.H. Wright) Friis & Nordal	92	herb
Apiaceae (=Umbelliferae)	<i>Caucalis</i> sp.	6	herb
	<i>Peucedanum aculeolatum</i> Oliv.	74	shrub
	<i>Sanicula elata</i> D. Don	127	herb
Brassicaceae (=Cruciferae)	<i>Cardamine africana</i> L.	88	herb
Celastraceae	<i>Maytenus acuminata</i> (L. f.) Loes.	120	tree
	<i>M. cf. undatus</i> (Thunb.) Blakelock	131	tree
Combretaceae	<i>Combretum</i> sp.	102	tree
Commelinaceae	<i>Aneilema beniniense</i> (P. Beauv.) Kunth	3	herb
	<i>Commelina africana</i> L.	39	herb
Cucurbitaceae	<i>Mukia maderaspatana</i> (L.) M. Roem.	133	herb
	<i>Zehneria scabra</i> (L. f.) Sond.	132	herb
Cyperaceae	<i>Carpha emini</i> (K. Schum.) C.B. Clarke	89	grass
Dennstaedtiaceae	<i>Hypolepis sparsisora</i> (Schrad.) Kuhn	135	herb
Euphorbiaceae	<i>Erythrococca</i> sp.	13	herb
Flacourtiaceae	<i>Casearia battiscombei</i> R.E. Fr.	134	tree
Lamiaceae (= Labiatae)	<i>Pycnostachys</i> sp.	138	shrub
Loranthaceae	<i>Phragmanthera rufescens</i> (DC.) Tiegh.	124	shrub
Meliaceae	<i>Lepidotrichilia volkensii</i> (Gürke) J.-F. Leroy	96	tree
Myrtaceae	<i>Syzygium gerrardii</i> Hochst.	40	tree
Oleaceae	<i>Jasminum</i> sp.	122	climber
Orchidaceae	<i>Polystachya stauroglossa</i> Kraenzl.	71	herb
Poaceae	<i>Megastachya mucronata</i> (Poir.) P. Beauv.	126	grass
	<i>Miscanthus violaceus</i> (K. Schum.) Pilg.	93	grass
	<i>Pseudoechinolaena polystachya</i> (Kunth) Stapf	128	grass
Polygonaceae	<i>Rumex bequaertii</i> De Wild.	136	herb
Polypodiaceae	<i>Elaphoglossum acrostichoides</i> (Hook. & Grev.) Schelpe	137	herb
Ranunculaceae	<i>Clenatis sinensis</i> Oliv.	110	climber
Rubiaceae	<i>Galium hamatum</i> A. Rich.	79	herb
Sapindaceae	<i>Allophylus macrobothrys</i> Gilg	28	tree
Urticaceae	<i>Elatostema monticolum</i> Hook.	58	herb
	<i>Laportea ovalifolia</i> (Schumach.) Dandy	53	herb
	<i>Pilea holstii</i> Engl.	101	herb
	<i>Pouzolzia parasitica</i> (Forssk.) Schweinf.	125	shrub

TABLE 8.—Usefulness of plant species

Species	Medicinal	Construction joinery & furniture	Craftwork	Food	Firewood	Miscellaneous
<i>Acalypha psilostachya</i>	+	—	—	—	—	+
<i>Adenia</i> sp.	—	+	—	—	—	—
<i>Alchemilla kiwuensis</i>	+	—	—	—	—	—
<i>Aningeria adolphi-fridericii</i>	+	—	—	—	—	—
<i>Anthericum</i> sp.	—	—	—	—	—	+
<i>Arundinaria alpina</i>	—	+	—	—	+	+
<i>Asplenium abyssinicum</i>	—	—	—	—	—	+
<i>aethiopicum</i>	—	—	—	—	—	+
<i>elliottii</i>	—	—	—	—	—	+
<i>erectum</i> var. <i>usambarense</i>	—	—	—	—	—	+
<i>inaequilaterale</i>	—	—	—	—	—	+
<i>linckii</i>	—	—	—	—	—	+
<i>Athyrium scandiacum</i>	—	—	—	—	—	+
<i>Basella alba</i>	—	—	—	—	—	+
<i>Brachystephanus coeruleus</i>	—	—	—	—	+	—
<i>Canthium oligocarpum</i>	—	+	+	—	—	—
<i>Capsicum annuum</i>	—	—	—	+	—	—
<i>Chenopodium ambrosioides</i>	+	—	—	—	—	—
<i>procerrum</i>	+	—	—	—	—	—
<i>Clerodendrum cf. johnstonii</i>	—	—	—	—	—	+
<i>Coccinia mildbraedii</i>	+	—	—	—	—	—
<i>Conarus longistipitatus</i>	+	—	—	—	—	—
<i>Cordia millenii</i>	—	+	+	—	—	—
<i>Crassocephalum</i> spp. (2 spp.)	+	—	—	—	—	—
<i>Cyathea mamiana</i>	—	+	—	—	—	—
<i>Cyathula cylindrica</i>	—	—	—	—	—	+
<i>Cyperus dereilema</i>	—	—	+	—	—	—
<i>Desmodium repandum</i>	+	—	—	—	—	—
<i>Dichrocephala integrifolia</i>	+	—	—	—	—	—
<i>Discopodium penninervium</i>	—	—	—	—	—	+
<i>Dombeya elliottii</i>	—	+	—	—	+	—
<i>Dracaena afromontana</i>	+	—	—	—	—	+
<i>Droguetia iwers</i>	—	—	+	—	—	—
<i>Embelia schimperii</i>	+	—	+	—	—	—
<i>Ensete edule</i>	+	—	+	—	—	—
<i>Eriosema</i> sp.	—	—	—	—	—	+
<i>Ficus natalensis</i>	—	—	+	—	—	—
<i>Galiniera saxifraga</i>	—	+	—	—	+	—
<i>Helichrysium</i> sp.	—	—	—	—	—	+
<i>Ilex mitis</i>	—	—	—	—	+	—
<i>Impatiens congolana</i>	—	—	—	+	—	—
<i>runssorensis</i>	—	—	—	+	—	—
<i>Ipomoea</i> sp.	—	+	—	—	—	—
<i>Lagenaria sphaerica</i>	+	—	—	—	—	—
<i>Maesa lanceolata</i>	+	—	—	+	+	—
<i>Macaranga kilimandscharica</i>	—	+	—	—	+	—
<i>Melchiora schliebenii</i>	—	+	+	—	+	—
<i>Mimulopsis runssorica</i>	—	—	—	—	+	+
<i>Mondia whitei</i>	+	—	—	—	—	—
<i>Momordica foetida</i>	+	—	—	—	—	—
<i>pterocharpa</i>	+	—	—	—	—	—
<i>Panicum trichocladium</i>	—	—	—	—	—	+
<i>Passiflora edulis</i>	—	—	—	+	—	—
<i>Peponium vogelii</i>	+	—	—	—	—	—
<i>Phyllanthus amarus</i>	—	—	—	—	—	+
<i>Piper capense</i>	+	—	—	—	—	—
<i>Plantago palmata</i>	+	—	—	—	—	—
<i>Plectranthus laxiflorus</i>	+	—	—	—	—	—
<i>Polygonum setosulum</i>	+	—	—	+	—	—
<i>Prunus africana</i>	—	+	—	—	—	—
<i>Psychotria mahonii</i> var. <i>puberula</i>	—	—	—	—	+	—
<i>Peridium aquilinum</i>	—	—	—	—	—	+
<i>Rapanea melanophloeos</i>	—	—	+	—	+	—
<i>Sida veronicifolia</i>	—	—	+	—	—	—
<i>Smilax anceps</i>	—	—	+	—	—	—
<i>Solanum aculeatissimum</i>	—	—	—	—	—	+
<i>nigrum</i>	—	—	—	+	—	—
<i>Strombosia scheffleri</i>	—	+	—	—	—	—
<i>Thelypteris dentatus</i>	—	+	—	—	—	—
<i>Thunbergia mildbraediana</i>	—	—	—	—	—	+
<i>Urena hypselodendron</i>	—	—	+	+	—	—
<i>Vernonia adolphi-fridericii</i>	—	—	—	—	+	+
<i>auriculifera</i>	—	—	—	—	+	+
<i>cinerea</i>	—	—	—	—	+	+
<i>syringifolia</i>	—	—	—	—	—	+
<i>Xymalos monospora</i>	—	+	+	—	+	—

+ useful; — not useful.



FIGURE 3.—A handbag made from vegetative parts of *Urera hypselodendron* and seeds of *Ensete edule* being sold in a shop in Bundibugyo town (26-9-91).

Vasquez *et al.* (1990) dealing with trees only, found that 60.1% of them were useful to the San Rafael community of northern Peru. These authors dealt with a larger number of tree species and individuals over a larger sample area than ours. However, our area appears to have a greater plant species richness.

The medicinal plants *Maesa lanceolata* and *Mondia whitei* which are used by the Bakonjo and Baamba as a remedy for stomachache and other bodily pains and increasing sexual potency in man, are also reported to be extensively used by the Zulu (Cunningham 1990) without mention of the purpose for which they were employed. *Piper capense*, *Plectranthus laxiflorus*, *Polygonum setosulum*, *Desmodium repandum*, *Crassocephalum* spp., *Dracaena afromontana*, *Momordica foetida*, *M. pterocarpa* and *Lagenaria sphaerica* were found to be used for medicinal purposes by the Bakonjo and Baamba people during this study. On the other hand, while species belonging to the genera *Acalypha*, *Asplenium*, *Phyllanthus* and *Syzygium* are used in a variety of non-medicinal ways by the Bakonjo and Baamba in Uganda, the Siberut of Indonesia and people of western Nigeria (Adjanohoun *et al.* 1990) use some species of the same genera specifically as medicinal plants (Wanda 1990). Whereas *Helichrysum* sp. is only used for carrying luggage by the Bakonjo and Baamba, it is a traditional Zulu medicinal plant (Cunningham 1990).

The most extensively exploited species was *Arundinaria alpina* (bamboo). Mostly dry or dead bamboos were harvested and used for construction of walls, roofs of houses and granaries by the Bakonjo and Baamba. Only a few species were actually shaped into planks because of the very difficult terrain or unavailability of modern equipment for saw milling. These species included *Cordia mellinii*, *Strombosia scheffleri*, *Cyathea manniana*. *Cyathea manniana* is known to be particularly resistant to attacks by termites.

Production of craftwork is becoming a fairly lucrative activity among the Bakonjo and Baamba. Some beautiful bags (Figure 3) made from vegetative parts of *Urera hyp-*

selodendron and seeds of *Ensete edule* are very marketable in many craftshops and other commercial outlets in Uganda. *Rapanea melanophloeos* (L.) Mez is used for craftwork by the Bakonjo and Baamba, whereas in the Kwa-Zulu-Natal region, it is a medicinal plant (Cunningham 1990).

Table 8 is a list of plant species and the variety of ways in which each species is used by the Bakonjo and Baamba. Only 5.2% (4/77) plant species are used for three different purposes. For instance *Maesa lanceolata* is used as medicinal plant, food and firewood. *Melchiora schliebenii* and *Xymalos monospora* are both used for construction/timber production, craftwork and food. Plant species used for two purposes, made up 22.1% (17/77) of the useful plant species and those with only one application made up 72.7% (56/77).

The degree of usefulness of families indicated in Table 9 shows that only Euphorbiaceae and Myrtaceae, 4.8% (2/42), had species put to four categories of use by the Bakonjo and Baamba; 11.9% (5/42) of the families have species put to three categories of use; 28.6% (12/42) to two categories of use; and 52.4% (22/42) families to one category of use. Representatives of 14 families were used medicinally, 13 families for construction, joinery and furniture and 12 for craftwork. Species of six families, the lowest number, were collected as food by the Bakonjo and Baamba. There were 15 families with no economic value to the Bakonjo and Baamba (Table 10).

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TABLE 9.—Degree of usefulness of families

Family	Medicinal	Construction, joinery & furniture	Craftwork	Food	Firewood	Miscellaneous
Acanthaceae	—	—	—	—	+	+
Agavaceae	—	—	—	—	—	+
Amaranthaceae	—	—	—	—	—	+
Aquifoliaceae	—	—	—	—	+	—
Asclepiadaceae	+	—	—	—	—	—
Aspleniaceae	+	—	—	—	+	+
Asteraceae	—	—	—	+	—	—
Balsaminaceae	—	—	—	+	—	—
Basellaceae	—	—	—	—	—	+
Boraginaceae	—	+	+	—	—	—
Chenopodiaceae	+	—	—	—	—	—
Connaraceae	—	—	+	—	—	—
Convolvulaceae	—	+	—	—	—	—
Cucurbitaceae	+	—	—	—	—	—
Cyatheaceae	—	+	—	—	—	—
Cyperaceae	—	—	+	—	—	—
Dennstaedtiaceae	—	—	—	—	—	+
Euphorbiaceae	+	+	—	—	+	—
Fabaceae	+	—	—	—	—	+
Liliaceae s.l.	+	—	—	—	—	+
Malvaceae	—	—	+	—	—	—
Monimiaceae	—	+	+	—	+	—
Moraceae	—	—	+	—	—	—
Musaceae	+	—	+	—	—	—
Myrtaceae	+	—	+	+	+	—
Olacaceae	—	+	—	—	—	—
Passifloraceae	—	+	—	+	—	—
Piperaceae	+	—	—	—	—	—
Plantaginaceae	+	—	—	—	—	—
Poaceae	—	+	—	—	+	+
Polygonaceae	+	—	—	+	—	+
Polypodiaceae	—	—	—	—	—	+
Rosaceae	+	+	—	—	—	—
Rubiaceae	—	+	+	—	+	—
Sapotaceae	—	+	+	—	—	—
Smilacaceae	—	—	+	—	—	—
Solanaceae	—	—	—	+	—	+
Sterculiaceae	—	+	—	—	+	—
Theaceae	—	+	+	—	—	—
Thelypteridaceae	—	—	—	—	—	+
Urticaceae	—	—	+	+	—	—
Verbenaceae	—	—	—	—	—	+

+ useful; — not useful.

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TABLE 10.—Plant families with no economic value to the Bakonjo and Baamba

Amaryllidaceae	Lamiaceae (= Labiatae)
Apiaceae	Meliaceae
Brassicaceae (= Cruciferae)	Myrsinaceae
Campanulaceae	Oleaceae
Celastraceae	Orchidaceae
Combretaceae	Ranunculaceae
Commelinaceae	Sapindaceae
Flacourtiaceae	

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Vegetation structure and small-scale pattern in Miombo Woodland, Marondera, Zimbabwe

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Keywords: disturbance, miombo woodland, small-scale patterning, soil properties, vegetation structures, woody species, Zimbabwe

ABSTRACT

The aim of this paper is to describe woodland structure and small-scale patterning of woody plants at a miombo site, and to relate these to past disturbance and soil properties. *Brachystegia spiciformis* Benth. and *Julbernardia globiflora* (Benth.) Troupin were the most frequent woody plants at the five hectare site, with size-class distributions which were markedly skewed towards the smaller size classes. The vegetation structure at the site and the increase in basal area over the past thirty years point to considerable disturbance prior to the present protected status. Six woodland subtypes were identified, grouped into two structural types: open and closed woodland. The distribution of woodland subtypes related closely to certain soil properties. It was hypothesized that the distribution of open and closed woodland is stable and a positive feedback mechanism by which this occurs is postulated.

UITTREKSEL

Die doel van hierdie artikel is om die bosveldstruktuur en kleinskaalse patroonvorming van houtagtige plante by 'n miombo-terrein te beskryf, en om hierdie verskynsels met versteuring in die verlede en met grondeienskappe in verband te bring. *Brachystegia spiciformis* Benth. en *Julbernardia globiflora* (Benth.) Troupin was die veelvuldigste houtagtige plante op die vyf-hektaar terrein, met grootte-orde verspreidings wat merkbaar na kleiner grootte-ordes geneig het. Die plantegroeistruktuur van die terrein en die toename in basale area oor die afgelope dertig jaar dui op aansienlike versteuring voor die huidige beskermde status. Ses bosveld-subtipes is geïdentifiseer en in twee strukturele tipes gegroepeer: oop en geslote bosveld. Die verspreiding van bosveld-subtipes het 'n noue verband met sekere grondtipes getoon. Aanspraak word daarop gemaak dat die verspreiding van oop en geslote bosveld stabiel is en 'n positiewe terugvoermeganisme waarvolgens dit plaasvind, word gepostuleer.

INTRODUCTION

Spatial heterogeneity is a universal attribute of natural vegetation (Greig-Smith 1979). Patterning exists and can be studied at various levels of biological organization and at widely different spatial and temporal scales (Allen & Starr 1982). For savanna vegetation, most studies have been concerned with regional and community patterns and their determinants and correlates (Walker 1987). Small-scale patterning (within community spatial heterogeneity) has received scant consideration (but see, for example, Macdonald 1978; Belsky 1983). Particularly the occurrence, determinants and dynamics of small-scale vegetation patterns in savannas remain poorly documented and understood. For instance, although Malaisse (1978), Celandier (1983) and Chidumayo (1993) have given details of general miombo structure, no information is available on small-scale pattern. In this study, small-scale patterning of the woody vegetation and correlates between woodland subtypes and various soil properties were investigated for a miombo woodland near Marondera, Zimbabwe.

SITE DESCRIPTION

The five ha study site is one of the intensive research sites of the Tropical Soil Biology and Fertility (TSBF)

Programme (Swift 1985). The site is located on the central plateau of Zimbabwe at Grasslands Research Station, 55 km southeast of Harare (18°10'S, 31°30'E). Altitude is 1 640 m. The climate is strongly seasonal, with over 80% of the mean annual rainfall of 885 mm (30 year average) falling between November and March. Mean monthly temperatures range from 11.7° C in June to 19.0° C in November. Night frost is not uncommon from mid-May until early August. Soils are strongly leached alfisols derived from granite. The site is on a gentle, north-facing slope.

The climax vegetation of the plateau, much of which has been cleared, comprises Deciduous Miombo Savanna Woodland (Wild & Barbosa 1967), in which the dominant species are *Brachystegia spiciformis* Benth. and *Julbernardia globiflora* (Benth.) Troupin. White (1983) classifies this vegetation as Zambeziian Miombo Woodland (the drier version). Fire and large herbivores have been excluded from the site for about the last thirty years.

METHODS

The occurrence and abundance of woody species was recorded during April 1986 in 36 contiguous 10 × 10 m plots, along three linear transects which were located with randomly selected starting points and a randomly selected direction within 20° of easterly (Figure 1). In each plot the identity, height and basal area at 1.3 m of all 'trees' (individuals with a circumference at breast height of at least 90 mm) were recorded. Heights were estimated visually to the nearest metre. For trees with multiple stems, the basal area of each stem was measured and these

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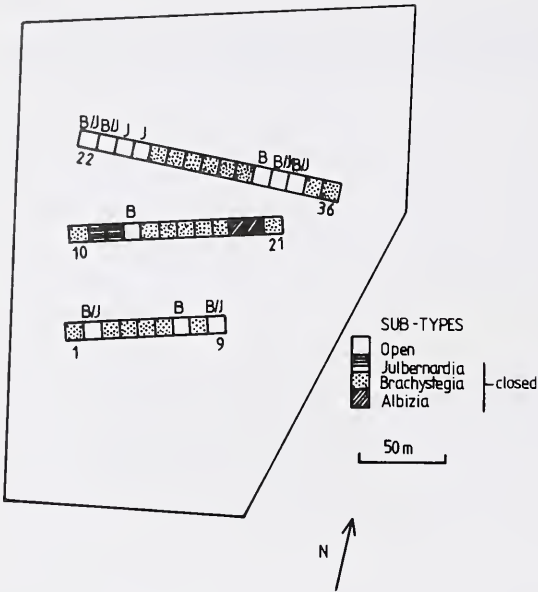


FIGURE 1.—The study site, showing the distribution of the woodland subtypes on the three transects. The transects and study area are drawn to scale. The subtypes of open woodland are indicated by B, *Brachystegia*; J, *Julbernardia*; and B/J, mixed *Brachystegia* and *Julbernardia*.

values were summed to give a total basal area for the individual. Woodland subtypes were identified using a cluster analysis (Campbell 1978) of the plot by species matrix, with basal area, on an ordinal scale, as the importance value.

Soil samples, each comprising four random subsamples bulked together, and infiltration rates were collected for each of the four woodland subtypes from the middle transect (Figure 1). The soil samples were from the top 100 mm. Infiltration rates were recorded as the seconds taken for 250 ml of water to infiltrate after pouring into an infiltration ring of 100 mm diameter. Soil analytical techniques followed Anderson & Ingram (1989).

Aerial photographs dating from 1946, 1967, 1973 and 1981 were used to determine past vegetation patterns and disturbance.

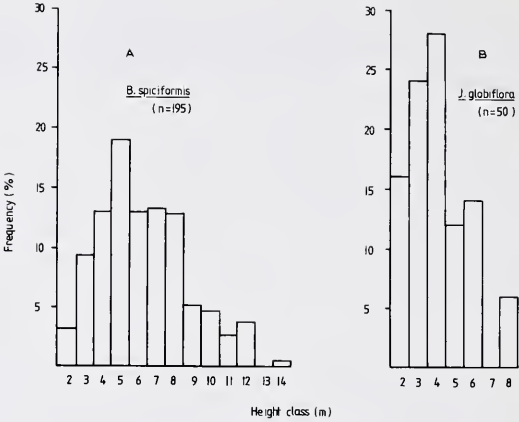


FIGURE 2.—Frequency distributions of tree heights for A, *B. spiciformis* and B, *J. globiflora* in a miombo woodland stand, Marondera.

RESULTS

Woody vegetation structure

B. spiciformis, which occurs in 94% of the plots, dominates the stand with eight times greater basal area than either of the species with the next highest basal area (*J. globiflora* and *Albizia antunesiana* Harms) (Table 1). In terms of density, *B. spiciformis* comprised 70% of all trees, and *J. globiflora* 18%. Average height did not exceed 7 m for any species (Table 1). Very few individuals exceeded 10 m in height, with the tallest tree encountered being 14 m.

Size-class distributions for *B. spiciformis* and *J. globiflora*, show that for both species there are many small individuals (Figures 2, 3). *B. spiciformis* individuals are markedly larger than those of *J. globiflora* in terms of both height and basal area. *B. spiciformis* and *J. globiflora* both have many individuals with multiple stems, with 39% and 36% of individuals respectively being multi-stemmed. It is particularly the larger individuals of the two species that have more than one stem (Table 2).

TABLE 1.—Frequency and means of tree density, stem density, basal area and height for the tree species in 36 plots in a miombo woodland, Marondera

Species	Frequency (%)	Tree density (#/ha)	Stem density (#/ha)	Basal area (m ² /ha)	Height (m)
<i>Brachystegia spiciformis</i>	94	547	864	7.73	6.25
<i>Julbernardia globiflora</i>	44	139	211	0.90	4.08
<i>Albizia antunesiana</i>	31	53	67	0.91	6.11
<i>Ekebergia benguelensis</i> Sparrm.	11	11	17	0.04	4.25
<i>Terminalia sericea</i>	6	11	14	0.04	3.75
<i>Acacia sieberiana</i>	3	6	14	0.26	6.50
Others (six spp.*)	17	19	19	0.03	2.67
TOTAL	100	786	1206	9.91	5.71

* Other species were *Ochna pulchra* Hook., *Parinari curatellifolia* Benth., *Strychnos cocculoides* Baker, *Strychnos spinosa* Lam., *Uapaca kirkiana* Müll. Arg. and *Vangueria infausta* Burch.

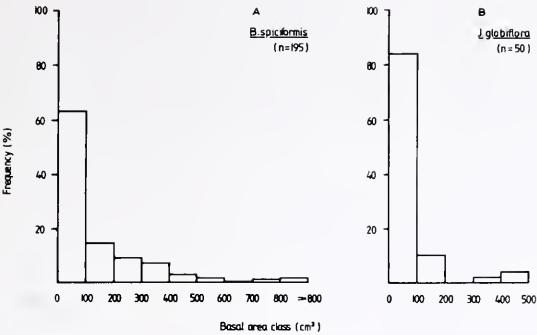


FIGURE 3.—Frequency distributions of basal areas for A. *B. spiciformis* and B. *J. globiflora* in a miombo woodland stand, Marondera.

TABLE 2.—Stem numbers per individual in relation to size for *B. spiciformis* and *J. globiflora* in a miombo woodland stand, Marondera

Size class	<i>B. spiciformis</i>		<i>J. globiflora</i>	
	n	Mean no. stems	n	Mean no. stems
Height (m)	0–3	25	1.32	20
	4–6	87	1.36	27
	7–9	61	1.89	3
	10–15	22	2.09	
Basal area (cm ²)			***	*
	0–100	123	1.30	42
	101–200	28	1.68	5
	201–400	30	2.10	1
	>400	14	3.00	2
			***	***

ANOVA: * = $p < 0.05$; *** = $p < 0.001$.

Within-stand pattern of woody vegetation

Numerical classification of the plots based on woody species composition produced six readily interpretable groups or subtypes of woodland (Figure 4). These six groups can in turn be placed into two woodland types according to structural criteria: open woodland and closed woodland (Table 3). The open woodland subtypes are dominated by *Brachystegia*, *Julbernardia* or a mixture of the two species, whereas the closed woodland is dominated by *Albizia*, *Brachystegia* or *Julbernardia*. Compared to closed woodland, open woodland is characterized by being less dense and by having shorter and slimmer trees (Table 3). The open *Julbernardia* subtype is particularly sparse and has the lowest total basal area and density per ha as well as the lowest richness and diversity of woody

plants. In terms of the tree floristics, the open and closed woodland types are not distinctive (Figure 4), as the two most frequent tree species, *B. spiciformis* and *J. globiflora*, are dominants in subtypes of both groups (Table 3).

The closed *Brachystegia* subtype is by far the most frequent at the site (Table 3). The distribution of subtypes along the transects is not random, with plots making up a subtype often being contiguous (Figure 1). The distribution amongst plots of the less frequent trees was also by no means random. For instance, for both *Terminalia sericea* DC. and the large trees of *A. antunesiana*, all individuals that were sampled occurred in adjacent plots,

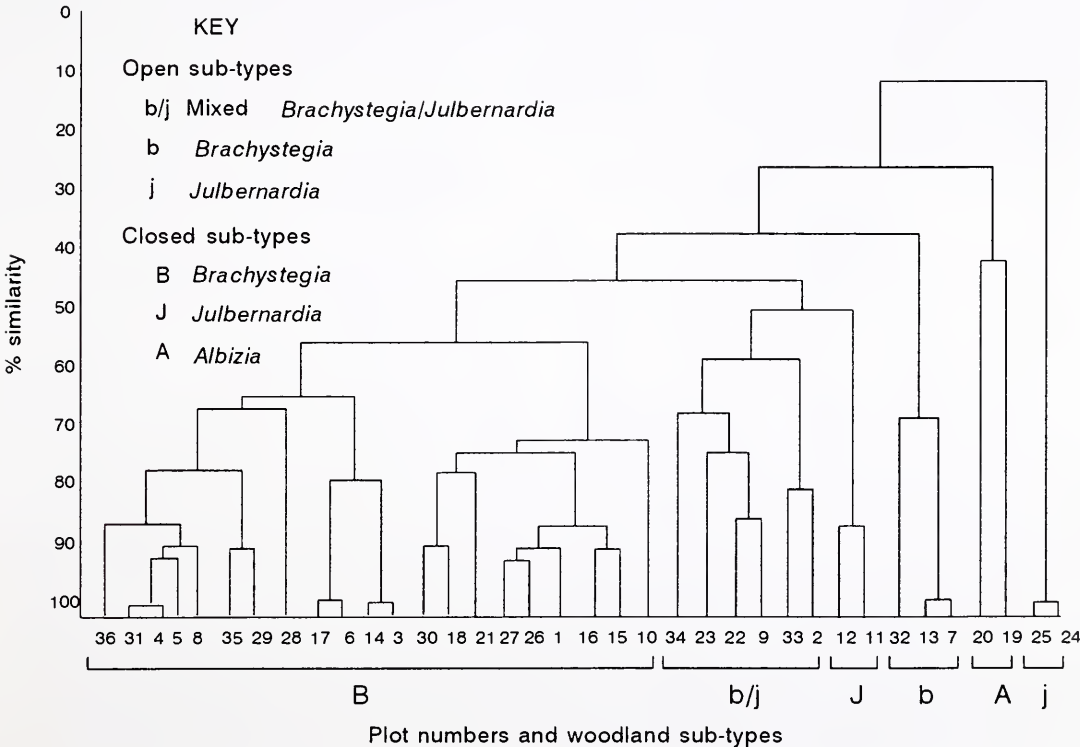


FIGURE 4.—Cluster analysis of 36 plots from a miombo woodland, Marondera, on the basis of woody species composition.

TABLE 3.—Characteristics of plots and trees of six woodland subtypes in a miombo woodland stand, Marondera

Woodland structural type		Open Woodland			Closed Woodland		Significance of ANOVA among all subtypes	Significance of contrast between open and closed woodland
Woodland subtype	<i>Brachystegia</i>	<i>Brachystegia/Julbernardia</i>	<i>Julbernardia</i>	<i>Albizia</i>	<i>Brachystegia</i>	<i>Julbernardia</i>		
Plot statistics								
Number of plots	3	6	2	2	21	2		
Mean tree density (#/ha)	433	600	200	800	910	1150	NS	**
Mean stem density (#/ha)	567	833	300	1300	1429	1750	*	*
Mean basal area (m ² /ha)	1.5	3.1	0.9	18.2	12.7	13.8	***	**
Dominant species (> 25% of individuals)	<i>Brachystegia</i>	<i>Brachystegia/Julbernardia</i>	<i>Julbernardia</i>	<i>Albizia Brachystegia</i>	<i>Brachystegia</i>	<i>Julbernardia</i>		
Dominant species (> 25% of basal area)	<i>Brachystegia</i>	<i>Brachystegia</i>	<i>Julbernardia</i>	<i>Albizia Acacia</i>	<i>Brachystegia</i>	<i>Julbernardia Brachystegia</i>		
Species richness (mean no. of species per plot)	1.3	2.7	1.0	2.5	2.2	2.5	NS	NS
Shannon-Weiner diversity index based on tree density	1.06	1.40	1.00	1.42	1.21	1.30	***	*
Tree statistics								
Number of individuals	13	36	4	16	191	23		
Mean basal area (cm ²)	34	52	43	228	140	120	***	*
Mean height (m)	4.1	3.9	3.8	7.9	6.1	5.2	***	***
Mean number of stems	1.31	1.39	1.50	1.63	1.57	1.52	NS	NS

NS = P > 0.05; * = P < 0.05; ** = P < 0.01; *** = P < 0.001.

whereas for both *Acacia sieberiana* DC. and *Vangueria infausta* Burch., all individuals sampled were located on a single plot. In this stand the shape and extent of open woodland patches along the transect, as observed on aerial photographs, have remained unchanged since 1946 when the earliest photographs were taken.

Amongst the closed woodland subtypes, which together occupy about 70% of the stand, there is a high degree of similarity in woodland height, basal area and density (Table 3). Accordingly, much of the small-scale variation within the stand is variation in species composition rather than variation in structure (Campbell *et al.* 1988). This is particularly so since the dominant trees of the three closed subtypes (*A. antunesiana*, *B. spiciformis* and *J. globiflora*) are similar in physiognomy, canopy shape, structure, leaf form and leaflet size.

Soil properties and woody vegetation pattern

The closed *Albizia* woodland subtype is located on terra maritima and has soils which differ from those of the other woodland subtypes in having higher contents of clay, silt, organic matter, moisture, calcium and magnesium (Table 4). Amongst the other three woodland subtypes present on the middle transect, the surface soils from the closed *Brachystegia* and *Julbernardia* plots are extremely similar, both in texture and chemical properties (Table 4), and therefore it is unlikely that soil properties are dictating the pattern amongst these woodland subtypes. In contrast, soils from the open woodland, although similar in texture to soils from the closed *Brachystegia* and *Julbernardia* plots, differ considerably from these in being more acidic and having lower infiltration rates, organic matter, moisture and nutrient contents (Table 4). The open woodland patches are strongly capped with a microfloral crust.

DISCUSSION

Based on woody species composition and abundance, the site is typical of miombo woodland as described by

Wild & Barbosa (1967) and White (1983), and has a similar stature, basal area and density to another, previously described miombo woodland that had also been protected from fire and cutting for 30 years (Strang 1974). However, when compared to miombo of sites with higher rainfall from Zambia, Zaïre and Tanzania, the trees are considerably smaller and the plot basal area is lower (Celander 1983; Malaisse 1978; Chidumayo 1993). It is difficult, however, to determine whether the differences are due to site potential or disturbance regimes.

Woodland cover was removed from the Grasslands Research Station after its establishment in 1929 (J. Clatworthy pers. comm.) and it is likely that the study site received this treatment. The high proportion of individuals with multiple stems attests to previous disturbance at the site. The fact that the smaller individuals in particular tend to be single-stemmed suggests that the site has been relatively free from disturbance over the last few decades. The present disturbance-free regime goes back at least to the mid-1950s, and the single aerial photograph from 1946 shows no major difference between the vegetation at that time and at present.

Strang (1965) estimated the combined basal area for *B. spiciformis* and *J. globiflora* at this Marondera site to be 7.2 m² per ha in 1963 as compared to 8.6 m² per ha as recorded in this study (Table 1). Therefore it appears that the woodland at the site is still maturing, albeit with minimal annual increment in basal area. The size distributions of the two most frequent species are more skewed towards the smaller size classes than are any of the distributions of the six common trees from the Nylsvley savanna in South Africa (Walker *et al.* 1986). This is further evidence that the woodland is still maturing. Some individuals present at the site were probably not felled when stumping took place, as was the case for an adjacent area in which the woodland was thinned out to a parkland containing seven to eleven large trees per ha (Ratray 1948). This would account for the low density (8.3 trees per ha) of very large (basal area greater than 800 cm²) *B. spiciformis* individuals.

TABLE 4.—Characteristics of soils from four woodland subtypes in a miombo woodland stand, Marondera

	Open <i>Brachystegia</i>	Closed <i>Albizia</i>	Closed <i>Brachystegia</i>	Closed <i>Julbernardia</i>	Total no. samples	d.f.	Signif.
Clay content (%)	14.3	24.3	12.4	13.0	8	4.4	*
Silt content (%)	1.6	4.0	2.0	2.6	8	3.4	NS
Sand content (%)	84.1	71.7	85.6	84.4	8	3.4	NS
Moisture content (%)	3.1	8.1	3.8	3.2	8	3.4	***
Organic matter content (%)	1.9	6.5	2.6	2.4	8	3.4	***
Infiltration rate (April) (seconds)	86.8	88.4	31.2	29.8	20	3.16	*
Infiltration rate (July) (seconds)	85.3	25.6	9.1	12.4	40	3.36	***
pH (April)	5.0	5.5	5.8	5.7	8	3.4	NS
pH (July)	4.8	5.5	5.7	5.4	24	3.20	***
Potassium (mg/100g Dw soil)	0.21	0.54	0.53	0.52	8	3.4	NS
Magnesium (mg/100g Dw soil)	0.97	3.59	1.74	1.97	8	3.4	NS
Calcium (mg/100g Dw soil)	0.24	1.39	0.76	0.76	8	3.4	NS
Phosphorus (mg/100g Dw soil)	0.13	0.18	0.67	0.30	8	3.4	*

ANOVA: NS = $p > 0.05$; * = $p < 0.05$; *** = $p < 0.001$.

There is considerable small-scale patterning of woody vegetation at the site. Some of this is simply explained by termite activity (Dangerfield 1990, 1993). The effects of mound-building termites on soils and vegetation are well documented (for example see Wild 1952; Hesse 1955; Glover *et al.* 1964; Lee & Wood 1971; Miedema & Van Vuure 1977). The result is the creation of nutrient-rich microsites which carry a characteristic flora.

It is hypothesized that the current distribution of open woodland is related to past human activities. It is suggested that past human activities have resulted in soil compaction and reduced infiltration. It is further hypothesized that a positive feedback mechanism prevents the re-establishment of closed woodland from open woodland. Open woodland occupies areas where the soil is strongly capped with a microfloral crust and water infiltration is low. Runoff from these areas is likely to be high, resulting in the removal of litter and seeds. This, in turn, will contribute to a low soil organic matter content. Conditions of low soil moisture, organic matter and nutrient levels, combined with low availability of propagules are unlikely to be conducive to the establishment of tree seedlings in these areas. Small-scale patterning of seedling recruitment at this site has been demonstrated by Grundy *et al.* (1994). Lack of seedling establishment will perpetuate the condition of low vegetation cover for these areas, and so the present soil conditions will be reinforced by this positive feedback loop. According to this argument, it can be predicted that the distribution of open and closed woodland should be relatively stable, unless root-coppicing has been substantial. This stability was confirmed through aerial photographic analysis. Campbell *et al.* (1988) suggest that the re-establishment of closed woodland on open woodland sites must await some disturbance that destroys the soil crust, such as the initiation of a termite mound. It is also possible that successful seedling establishment may occur in the open woodland areas under exceptional climatic conditions. Belsky (1986) and Macdonald (1978) have suggested a similar positive feedback mechanism, based on different water infiltration rates, for the stable persistence of two discrete herbaceous vegetation phases in grasslands, on soils which are derived from the same parent material and which do not differ in particle-size distribution.

CONCLUSIONS

Considerable small-scale pattern was found to exist within the woody vegetation at this site, and it is suggested that these patterns are relatively stable through time. Much, but not all, of the spatial heterogeneity in the woody vegetation correlates to various physical and chemical soil properties. Such small-scale vegetation patterning will have significant impact on patterns of within-stand nutrient cycling and hence soil properties, as discussed by Campbell *et al.* (1988).

ACKNOWLEDGEMENTS

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Book Reviews

A KEY TO AUSTRALIAN GRASSES, 2nd edn, by B.K. Simon. 1993. *Queensland Department of Primary Industries*, GPO Box 46, Brisbane, Qld 4001. ISBN 0 7242 5381 5. Pp. vii + 206. Price: soft cover, Australian \$35.00.

This second edition, like its predecessor, can be recommended for its simplicity and user-friendly layout. It incorporates numerous new features such as the larger font which makes for much easier reading.

The introduction is divided into a number of subheadings. It gives a short overview on the construction and history of the layout. There is a note on the different characters used to classify grasses from the days of Palisot de Beauvois (1812) to the modern day works of Watson *et al.* (1985) and Clayton & Renvoize (1986). The author then gives his own classification of the Australian grasses. Under notes on grass identification, reasons are given as to why artificial botanical keys are more practical for identification than natural keys. There are a few useful hints on the dissection of a spikelet, followed by a short but clear explanation on computer-generated keys using the DELTA (DEscription Language for TAXonomy) system. The differences between the generic concepts of Watson and co-workers and those of the author are discussed.

A very useful glossary explains scientific terminology used in the book. Under the heading 'Illustrations' there are stylized drawings showing the structure of a grass spikelet and the diagnostic characters of Australian grass tribes and subtribes. The use of shading for highlighting the different parts of the spikelet is very effective.

There are two keys to the genera. Key 1 was generated by the author himself around the same framework as that in edition 1. Key 2, extracted from the world database of Watson & Dallwitz (1992), was supplied by Watson. In key 1 the couplets are brief and therefore tend to be easy to use. However, the novice may find certain characters difficult to use without additional information. An example is the very difficult character 'Annual or perennial'. The inclusion of key 2 may alleviate the difficulty to some extent since other and/or more features are often employed. But in computer-generated keys the characters used are often difficult to see or are not present on herbarium specimens. An example is the question 'shoots aromatic' or not.

The genera are arranged in alphabetical order. Related genera are consequently not grouped together but the index need not be referred to continually. This arrangement also tends to be more stable since advances in knowledge often result in changes to the classification. At the beginning of each genus a few abbreviated references are mentioned. These are then given in full at the end of the book before the index.

The keys to species are similarly short, with the current name in bold followed by the distribution in Australia in brackets. Although the use of abbreviations rather than symbols is an improvement, the map of Australia should have been retained. Below each name the most recent synonym and/or misapplied name is given in italics. Naturalised entities are marked by an asterisk (*) throughout the book. This is very useful, especially to scientists in applied fields.

A few minor technical points worthy of attention in future editions: include the abbreviation 'auct.' in the glossary; distinguish between dashes and hyphens; on p. 61 add under 'Key to species' the meaning of \times in front of the genus or plant name and repeat explanation for *; p. 143 under *Pentascistis*, cite Linder & Ellis (1990); p. 147 line 5 from below: lemmas 2.0–2.5 mm; p. 149 line 3 from below: nerves; p. 150 couplet 49: 'internerves' of what?; p. 180 line 3: Plantarum; p. 178–183 references: at least minimal use of end-of-line hyphenation should be considered; p. 199 column 1 line 2 from below: Parodi. The following terms should be added to the glossary: spicate, nodular, internerves.

This second edition, with the expanded and informative introduction, the glossary, the additional computer-generated key to genera and the

updated taxonomic information, is a clear advance on the first edition and is highly recommended.

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L. FISH

FLORA OF AUSTRALIA Volume 49: Oceanic Islands 1, edited by A.E. Orchard & A.J.G. Wilson. 1994. *Australian Government Publishing Service*, GPO Box 84, Canberra ACT 2601. Price: Cat. No. 93 1664 3 Paperback \$54.95; Cat. No. 93 1665 5 Hard cover \$64.95.

Like Volume 50, which preceded Volume 49, this work deals with all the vascular plants present on two major islands off the east coast of Australia. The islands in question are Norfolk and Lord Howe Islands, which together comprise 51.16 km², a minute portion of the earth's surface. There are 361 naturalised plants in addition to the 345 indigenous species, of which 149 (44.9%) are endemic. Unfortunately, it is not clear whether endemic refers to only these two islands or whether it includes other major, adjacent islands such as New Caledonia and New Zealand. If the former, $\frac{3}{10}$ of the world's surface supports $\frac{1}{10}$ of the world's flora that does not occur elsewhere. The degree of endemism at the specific level is thus extremely high and, with the exceptionally high score of seven endemic genera, this publication is of particular interest.

The publication comprises a dedication to Ru Hoogland, a brief introduction to the rationale, scope and presentation of the volume, a brief discussion of the vegetation of the two islands, a bibliography, a key to the families, accounts of all the families, an appendix dealing with some nomenclatural matters, a glossary, a list of abbreviations and contractions, publication dates of previous volumes in the series and an extensive index.

The volume is dedicated to Ruud Dirk Hoogland in recognition of his contribution to the development of the Australian National Herbarium and the contribution that he made indirectly to the volume by his extensive collections and very extensive notes and indices that he made available to the author. Ru Hoogland died suddenly in December 1994, after an operation in Paris.

The introduction to the rationale, scope and presentation of the volume includes the history of the development of the volumes on Oceanic Islands, the reason for combining the family accounts for the two islands and the arrangement of the volume. A list of the small islands that are included as part of the two larger islands, a note on the authorship of the volume and notes on the composition and presentation of the following sections are included, as are the policy on common names, the source of information on flowering time and the basis for the selection of species for illustration. This is followed by acknowledgements by the Australian Biological Resources Study and Peter Green, the major author.

The discussion of the vegetation of the islands includes a general introduction to both islands, and for each island a general introduction, a description of the vegetation and a list of species, indicating which are endemic, indigenous and naturalised. At the end of this section there is a note on conservation on the two islands. The beginning of this section very briefly places the flora of the two islands in context of the southeastern Pacific Ocean flora, but states that an analysis of the floristic affinities of the two islands was beyond the immediate scope of the work.

The key to families is consolidated for both islands (unlike in Volume 50 which has a key for each island). We have tried running a few characteristic families through the numbered, indented key and found that it worked well and was easy to follow. The terminology is simple for botanists but amateurs may find some words rather technical. The list of exceptions to a step (e.g. the first part of step 3 on p. 27) is very helpful, as are the page references for other parts of the couplets (unfortunately step 33 is given as p. 34 instead of p. 33). We would prefer to see lines of dots leading to the family names in the key, but even more helpful would be page numbers on which the families occur, rather than the family numbers. This would reduce the amount of paging that needs to be done or the necessity to look up the page number in the index or table of contents.

The accounts of families, genera and species are neatly laid out and are clear, concise and informative. They cover 706 species in 136 families, the biggest of which are Poaceae (51 genera), Asteraceae (40 genera) and Fabaceae (23 genera). The families are ordered following the system of Cronquist, but we could not discover whether any particular order was used for the genera (they are not alphabetical). They presumably follow some more meaningful phylogenetic arrangement. The inclusion of taxa that have only been recorded in literature and for which there are no voucher specimens (e.g. Ebenaceae, p. 148), is extremely helpful and indicates that the author is aware of the situation. The treatments of families include descriptions, keys to genera, descriptions of genera, discussions, keys to species and accounts of the species. Accounts of species include citation of types, etymology, references to illustrations in other works, descriptions, common names, local distribution, ecological notes, global distribution, vouchers (with herbaria cited) and a discussion.

The nomenclatural appendix includes the description of a new species and subspecies and the lectotypification of a name. The glossary is quite extensive, with approximately 900 terms defined. The lists of abbreviations and contractions cover literature, herbaria, states, territories and nearby countries, general abbreviations and symbols. The single index is comprehensive, including scientific names in current use, synonyms and common names. We prefer single comprehensive indices, to separate indices for scientific names and common names.

There is a helpful comment on the back of the title page indicating how individual contributions should be cited, but it is only in a brief note in the introduction that the issue of authorship is clarified. We believe that a disservice is done to the major author, as few readers dipping into the volume for information on particular groups will actually discover who the author is. We think the situation should have been made clearer on the title page, in the table of contents or on page xi, where the contributors are listed.

There are 104 figures in the volume, including 63 colour plates (figures 1–30 and 50–81), 3 maps (figures 32–34) and 38 plates of line drawings of 4–5 plants each (figures 35–40 and 82–104). The colour plates provide spectacular views of the islands (figures 1–6 & 74) and good illustrations of many of the plants, some of them showing elements of the habitat. Captions include the name of the plant, the name of the island on which the plant was photographed and the name of the photographer. Unfortunately, the family names are omitted, as are magnifications. We feel that the former reduces the educational value of the photographs, because in order to find the family of a featured plant, one has to page to the index, then to the section in the book and then back to the photograph to look for family characteristics. Although generally accurate and clear, we felt that the quality of the line drawings is not of the same very high quality of those in Volume 50, with figure 83. A being a particular case in point.

In our review of Volume 50 (Bothalia 24: 262) we hoped that Volume 49 would include an introduction to the floras of all the islands and indicate the relationship to the rest of the Australian flora. Although some information is provided in the introduction to the floras of Norfolk and Lord Howe Islands, there is no information on the relationship of these floras to those of other islands, nor to the Australian flora as a whole.

Considering the geographical distance and climatic differences between the islands, it seems that this expectation of ours was unrealistic.

Overall, this volume, like Volume 50, is an excellent piece of scientific work. The volume is presented in a user-friendly and appealing manner and is an example to be followed.

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DIVERSITY AND EVOLUTIONARY BIOLOGY OF TROPICAL FLOWERS by P.K. ENDRESS. 1994. *Cambridge University Press*, The Pitt Building, Trumpington St, Cambridge CB2 1RP. Pp. 511. ISBN 0 521 42088 1. Price: £55.00.

This is one of the Cambridge Tropical Biology Series and maintains the high standards which have become associated with the Cambridge University Press. Peter Endress, although based in Zürich, has a long and productive association with the tropics and maintains that he actually started this book during the monsoon in Java. Endress is a developmental morphologist who has published extensively on floral structure and development in primitive groups of flowering plants. His approach to the topic in hand is decidedly that of an evolutionary morphologist. This provides a refreshing zest to a topic which is not well documented experimentally and thus liable to an uncritical and even anecdotal exposition. Indeed he starts off by citing the instance of that most familiar of tropical ornamental trees, the Flamboyant, *Delonix regia*. For all its obvious attractions little is known about its reproductive biology in the wild (although I think the fact that it is rare in its natural home in Madagascar might well have something to do with this). But the point is well made nevertheless. The biology of flowers can provide insights into trophic and evolutionary relationships within the community. This facilitates an understanding of community dynamics which could not be gleaned from even the most comprehensive checklist. Anyway, a botanical inventory of the tropics is still far from complete, yet even as new species are being described, others are disappearing and all that is known to Science about them are their names. After all, the most informative aspect of a species is not what it looks like but how it functions. Endress is aware of this, and while nothing in his book is startlingly new, it is a compelling synthesis which provides a firm grounding, both philosophically and intellectually, from which to proceed.

The comparative study of flowers began in the temperate regions. While unusual and highly specialised pollination systems do occur in temperate Europe and America, they are more common in the tropics, probably mostly for the same reasons that there are more species in the tropics. The study of floral biology in all regions of the tropics, but especially the Neotropics, has expanded rapidly over the last three decades and it is Endress' intent in this book to summarise and expose these exciting advances to the general biologist. Not being a reproductive biologist, he is not biased towards any particular thinking on the topic and the sections in his book dealing with these aspects are more in the nature of summaries of published thinking, leaving the reader free to investigate further. His particular intelligence is most evident in the sections on morphology.

The book starts with a brief, whorl by whorl account of the components of the flower, not as a structural stocktake, but as an introduction to the basic tenets of floral organisation and ontogeny. The integrated nature of the parts and their shifting functions are emphasised and various aberrant types mentioned. A strong evolutionary bias permeates this section and all variations are examined from the perspective of their possible evolutionary status. The scanning electron micrographs of uncommon types of anther dehiscence are delightful.

The central part of the book concentrates on floral function. It opens with a summary of various classes of pollinating agents and some floral adaptations. This sets the scene for a basic introduction to current comprehension of the various structural specialisations and behavioural strategies developed by plants for attracting and rewarding pollinators or even avoiding them entirely. These include floral rewards, pollinator attractants, reproductive strategies and breeding systems. Although none of the topics is thoroughly discussed the salient points are there and the accounts serve as good starting points for anyone studying any aspects

of floral biology. The importance of floral guilds in tropical communities, for instance, has been greatly overlooked and mention of them here may stimulate field workers to identify and document them more fully. They provide the key to understanding the origin of many particular floral forms which cannot be readily explained when the genus is examined in isolation. By summarising contemporary concepts in the field Endress provides both a wider paradigm for interpreting pollination biology and a convenient source of seminal references. Here in one place is enough to give any biologist a good idea of the kind of advances which have been made and where to start researching further, without getting caught up in detailed examination of specific instances. I challenge any general biologist to read these chapters without being thrilled at the exquisite strategies developed by plants and experiencing again the thrill of real life.

The second half of the book is largely taken up by examples of the structural and biological idiosyncrasies evident in selected tropical taxa. These range from some of the smaller Magnoliid families with rather insignificant flowers through the bizarre Rafflesiaceae, which contain the largest flowers in the kingdom; those masters of symmetry the Passifloraceae, which contrast greatly with the largely asymmetrical Scrophulariales although both exploit a range of similar pollinators; and that ubiquitous tropical group the Fabales, to the Zingiberales and inevitably the Orchidales, along with a number of others. Throughout this section Endress manages to keep the evolutionary thread intact and the examples gain in impact when placed in their functional and phylogenetic context. Something which struck me was the paucity of references to African examples. Studies in pollination biology are in their infancy here, and while some interesting work has been done in the last three years

it is too recent for inclusion in this book. With Endress' book now available, we no longer have an excuse.

Endress ends with a miscellany of hints for a better understanding of flowers. It is particularly necessary to be aware of the historical context in which the existing form has developed. Structural constraints are an important legacy of ancestry and influence subsequent elaboration and diversification. No organism can develop structures nor strategies without constraint. In fact the strength of selection is most telling when it can be seen to have resulted in a transference of function. The use of leaves or bracts as attractive structures is an example easily called to mind, but the plants dealt with here provide an array of instances which are far more astounding.

We are only beginning to understand the diversity of living organisms in a way which sheds meaning on the dynamics of existence and exploitation. Endress' book is an admirable introduction to this. His strong evolutionary bias removes it from the ranks of a descriptive guide and makes for a fascinating philosophical introduction to floral form and function. I can never again regard flowers as more or less sculptural agglomerations—read this book, and neither will you.

J. MANNING*

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IN MEMORIAM

During the second half of 1994 three highly esteemed supporters and associates of this journal passed away:

Jan Kornaś (26 April 1923–8 August 1994). Botanist, author of numerous works on plant taxonomy, phytogeography (African vegetation), ecology and nature conservation; Professor at the Jagiellonian University of Krakow and Director of the Institute of Botany at this university until 1992.

Ellaphie Ward-Hilhorst (10 July 1920–30 June 1994). One of South Africa's most distinguished botanical artists; during the last 24 years of her life she produced some 800 plant portraits, in particular of species of *Pelargonium*, and gained international recognition as one of the great exponents of her art.

Frank White (5 March 1927–12 September 1994). A foremost student of the African flora and vegetation; curator for almost 30 years of the Forest Herbarium and the Fielding-Druce Herbarium at Oxford; well known for his work on the forest flora of tropical Africa, in particular on Ebenaceae and Meliaceae, and his vegetation map of Africa.

VALUABLE BOOKS MISSING

The following ten rare works were found to be missing from the Mary Gunn Library, National Botanical Institute, Pretoria, during the recent stock-taking in February 1995.

BERGIUS, Petrus Jonas

Descriptiones plantarum ex Capite Bonae Spei. 1767. Salvii, Stockholm.

COMMELIN, Caspari

Praeludia botanica. 1703. Also contains: *Horti medici Amstelaedamensis plantae rariores et exoticae*. 1706. Lugduni Batavorum, Harlingh.

JACQUIN, Nicolao Josepho

Miscellanea austriaca. 1778–1781. Vindobonae, Krausiana.

LATROBE, C

Journal of a visit to South Africa in 1815 and 1816. 1818. Seeley, London.

LICHTENSTEIN, Henry

Travels in Southern Africa, in the years 1803, 1804, 1805 and 1806. 1812. Colburn, London.

LINNAEUS, C.

Species plantarum. 1753. Salvii, Stockholm.

LINNAEUS, C.

Systema vegetabilium. Roemer, J.J. & Schultes, J.A. (eds), 16th edn. 1817–30. Cottae, Stuttgart.

PETIVER, Jacobo

Musei Petiveriani centuria prima. 1695. Smith, Londini.

THUNBERG, Carl Pehr

Dissertatio botanica de Erica. 1785. Edman, Upsaliae.

THUNBERG, Carl Pehr

Flora capensis. 1823. Cottae, Stuttgart.

These books were either in their original binding or bound in recent years in half-leather by the Pretoria Bookbinders. They were all clearly stamped, mostly on the back of the title page, with stamps of the Department of Agriculture or of the Botanical Research Institute.

The NBI offers a reward for any information that will lead to the recovery of one or more of these rare volumes.

BOTHALIA

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